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Diatoms of Malayan Freshwaters

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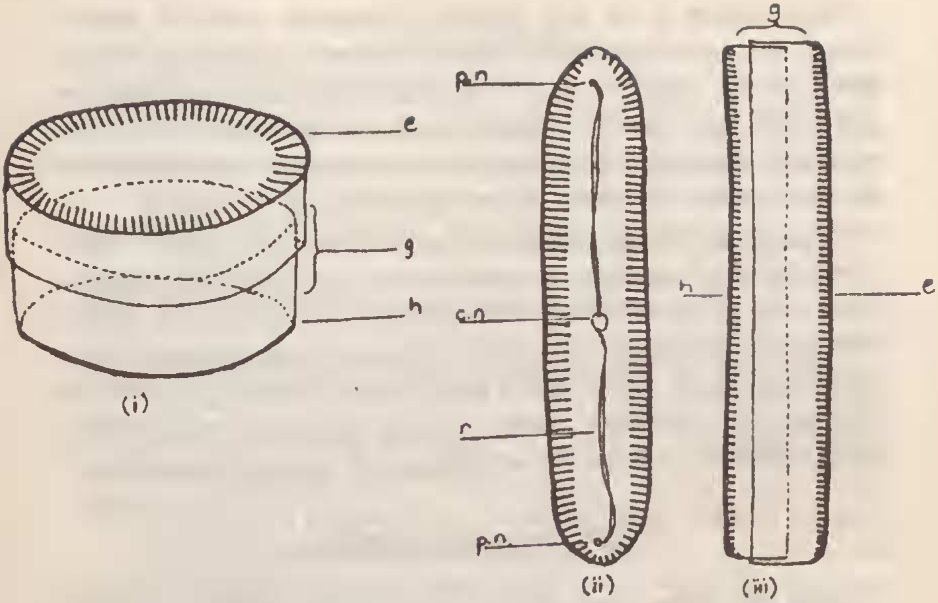
DIATOMS or Bacillariophyceae are a class of algae which have probably been studied more thoroughly taxonomically than any other class, but whilst there are extensive accounts of species from Indonesia and other parts of S.E. Asia, little seems to have been published on those species occurring in Malaya itself (I here take as my geographical boundaries the Federation of Malaya and Singapore). Apart from a paper by Ruth Patrick (1936) describing some 73 species and forms from Perak, virtually nothing has been published on Malayan species. This present paper is an attempt to rectify that position, but as it includes only those species which I have seen and drawn myself it can in no way be regarded as a complete account of Malayan freshwater diatoms. Several of the species described by Ruth Patrick are absent from this paper, whilst many others are described which are not mentioned in her paper. A few others which I have seen have been excluded because material has been too scanty and imperfect for accurate identification. A number of species described here are usually regarded as marine forms; whilst it is quite possible that they are of marine origin, they were found in quite non-saline water, fully alive and often dividing, and in some cases occurring together with healthy, dividing specimens of such notorious halophobes as the larger desmids. This fact is not really surprising. Malaya is surrounded by seas which are frequently subjected to torrential rainfall and the coastal waters must become heavy diluted. At times some of the marine organisms must be existing in pockets of almost pure water. Such organisms must be highly adaptable to survive, and if they are carried inland by tidal rivers they might quite easily survive or even multiply in freshwaters inland. Several species of *Coscinodiscus, Stephanodiscus, Cyclotella* and *Nitzschia* fall within this category.

Whilst most species mentioned have been recorded elsewhere, several new taxa are described, but these are forms which have unmistakable characteristics. Some authors may decide others of the forms described should be separated as new taxa, but my own opinion is that the differences from previously described forms are too slight to warrant such separation. Despite the vast amount of work which has been done on the morphology of diatoms, we still know far too little about the physiological development, the genetics and ecology of them. Culture work and statistical studies of morphological forms have shown that in some cases at least so-called varieties are merely nutritional forms, whilst in other cases they have emphasized the differences between closely similar forms. For this reason I have thought it better not to separate off varieties and forms simply on the basis of slight differences in shape and the number of striae.

Since the illustrations in this paper are all original, done under phase contrast with the aid of a camera lucida, any errors or inaccuracies are therefore my own responsibility. Identifications have been carried out with the aid of standard works of A. Cleve-Euler, Hustedt, particularly in "Die Tropischebinnengewasser", De Toni's "Sylloge Algarum" and others, as well as several papers, all of which are quoted in the bibliography. Schmidt's Atlas and Van Heurck's works are not yet available in Malaya, and it has not been possible to refer to them; all identifications have been made through the works of other authors.

The Bacillariophyceae or diatoms form a well-marked class of algae with very distinctive features, and are unicellular, or form simple colonies. Each has a silicified cell wall or *frustule* composed of two distinguishable "halves", one of which overlaps the other rather like a lid on a date box. The cell wall is composed of pectic compounds, usually heavily impregnated with silica; cellulose has been reported, but accounts are rather contradictory, and it is certainly not a regular constituent of the wall. Each "half" consists of a somewhat flattened valve attached at the margins to a connecting band, the girdle or *cingulum*. The *cingulum* extends almost completely round the periphery of the valve, but there is always a gap between the two ends. The longer overlapping valve is known as the *epivalve* or *epitheca,* and the shorter as the *hypovalve* or *hypotheca.* Thus there are two characteristic views of the diatom, the *valve view* with the valve side uppermost, and the *girdle view* with the cingulum lying uppermost. In addition to the cingulum some genera exhibit one or more intercalary bands. The valves, are variously ornamented with coarse or fine *striae, punctae* or *areolae* which radiate from a central point in the centric genera, or bilaterally with respect to an axial field in the pennate genera. The axial field, which may be symmetric or asymmetric with respect to the longitudinal axis, usually appears as a clear



Text fig. 1

Views of diatoms (diagrammatic).
(i) oblique view of a centric diatom *Cyclotella*
(ii) valve view of a pennate diatom *Pinnularia*
(iii) girdle view of *Pinnularia*.

e, epivalve; h, hypovalve; g, girdle or *cingulum;* r, raphe; p.n., polar nodules; c.n., central nodule.

band between the striae. It may be perforated by a complex longitudinal slot or *raphe*. The raphe usually has thickenings in the walls at each end and at the centre, the *polar* and *central nodules*. In the absence of a raphe the axial field is known as a *pseudoraphe*. The ornamentations are usually thin places in the silicified wall, although small pores may perforate the walls within the areolae of some centric diatoms, and in a few pennate species there are longer median or polar perforations.

The chromatophores, which are rarely absent, are usually numerous and discoid or irregular in the Centrales, and single, lobed and perforate, or two and laminate in the Pennales. The colour is usually golden brown, but sometimes bright green, especially in specimens from organic bottoms in ponds and lakes. Pyrenoids, always without a starch sheath, may or may not be present. The photosynthetic pigments consist of chlorophylls a and c, usually obscured by β- and ε- carotene and five xanthophylls; chlorophyll b is absent. Reserve foods include fats in the form of oil droplets, volutin and leucosin, but never starch.

Many pennate diatoms exhibit motility, moving forward and backward in the direction of the long axis of the cell. Movement is confined to those species possessing raphes, and is ascribed to the streaming of cytoplasm between the polar and the central nodules through fissures on the outer wall faces.

Reproduction is by cell division, statospores (cysts or endospores) and auxospores which may be formed without any sexual union, or by fusion either of amoeboid gametes, or of autogamous nuclei, and uni- or biflagellate microspores which have been variously interpreted as zoospores or gametes. In the species so far investigated the nuclei of the vegetative cells are diploid.

Diatoms are widely distributed in fresh and salt waters, often becoming very abundant in colder waters and in colder seasons. They may be free-floating, often pelagic, or they may be sessile forming an important part of the lithophytic and epiphytic flora. In flowing waters many species form copious gelatinous masses on rock surfaces. Although diatoms are mostly aquatic, many species occur within the soil and on wet surfaces of terrestrial substrates.

KEY TO THE GENERA

Since this paper must be very incomplete, only a key to the genera is provided, the species being described under each genus in alphabetical order.

Valves orientated about a central point with ornamentation radial or concentric; raphe or pseudoraphe absent .. I. CENTRALES.

Valves orientated about a longitudinal axial field, with the ornamentation bilateral to it and not radiating from a central point; raphe or pseudoraphe present .. .. .. II. PENNALES.

I. ORDER CENTRALES

Cells solitary or united variously into filaments, dendroid or zigzag colonies, free-floating or sessile; cell-shape discoid, cylindric or irregular, with valves round, elliptic, polygonal or irregular; ornamentation radial or concentric about a central point; raphe or pseudoraphe absent, cells immobile, often with spine-like, mamillate or long horn like projections; chromatophores usually numerous, small, discoid and often irregular and laminate, with or without pyrenoids; reproduction by cell formed by rejuvenescence, and enlargement of cells without sexual reproduction; some genera known to have diploid vegetative cells and autogamous sexual reproduction. Largely a marine order, with a few freshwater species.

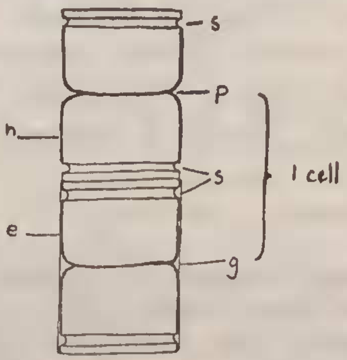
Key to Centrales

(i) Cells united into long filaments .... (ii)
(i) Cells not united into long filaments; at most short chains (iii)
(ii) Valves circular with short teeth or spines at the periphery 1. *Melosira*
(ii) Valves elliptic with two very long spines at the ends of the longer axis .... 6. *Chaetoceros*
(iii) Cells a long cylinder with a long terminal spine at each end 7. *Rhizosolenia*
(iii) Cells disc-shaped or squat cylinders with no long terminal spine .... (iv)
(iv) Valves with coarse areolae .... 3. *Coscinodiscus*
(iv) Valves punctate, not areolate .... (v)
(v) Valves with a peripheral ring of short spines. No well marked outer zone of striae or punctae .... (vi)
(v) Valves without a ring of short spines, but with a well marked outer zone of striae or punctae .... 2. *Cyclotella*
(vi) Peripheral spines very small, striae very fine, hardly visible 4. *Thalassiosira*
(vi) Peripheral spines larger and conical, striae well-marked 5. *Stephanodiscus*

MELOSIRA C. A. Agardh 1824

Cells cylindrical, united into long filaments; valve view circular, with or without marginal teeth, flat or convex, usually with ornamentations in two distinct concentric areas; girdles with *sulcus* or groove, *pseudosulcus* or without either; when sulcus or pseudosulcus absent central area of girdle usually ornamented, when present central area usually smooth; chromatophores numerous, small, discoid, frequently crowded.

Auxospore formation asexual or autogamous; biflagellate zoospores reported.



Text fig. 2

Girdle view of Melosira showing a single cell with a semicell attached at either end. e, epivalve; h, hypovalve; s, sulcus; p, pseudosulcus; g, girdle of parent cell.

1. **Melosira granulata** (Ehrenberg) Ralfs. [Syn.: *Gaillonella granulata* Ehr.; *G. procera* Ehr.; *G. marchica* Ehr.; *Melosira ordinata* Kuetz.; *Orthosira punctata* W. Smith.] Cells 16μ long × 10μ diameter to 28μ long × 5μ diameter; sulcus shallow and acute; valves with short marginal teeth, but end cells bearing also a few long marginal spines; punctae of valve view large, scattered; girdle view coarsely punctate, in parallel striations which are straight or only very slightly spiral, 8–11 striae in 10μ. (Pl. I, figs. a & b). The slender form has been separated as var. *angustissima,* but observations here and in the river Nile suggest that it may only be a growth form resulting from decreasing mineral supplies (Prowse & Talling 1958).

MALAYA Perak: Taiping Lakes.
Selangor: Common in established fish-ponds.
Negri Sembilan: Common in established fish-ponds.
Malacca: Common in established fish-ponds.
Singapore: Common in established fish-ponds; Botanic Gardens Lake.

Distribution worldwide.

2. **Melosira italica** (Ehrenberg) Kuetzing. [Syn.: *Gaillonella italica* Ehr.; *Melosira crenulata* Kuetz.; *M. crenulata* Kuetz. var. *italica* Grun.; *M. crenulata* Kuetz. var. *tenuis* Grun.] Gells 16μ long × 9–10μ diameter to 28μ long × 5μ diameter; sulcus shallow, acute; valves with prominent marginal teeth, alike on end and intercalary cells, with no long spines; valve view very finely punctate; girdle view finely punctate in spiral striations which are sometimes undulate or intersecting, 10–20 striae in 10μ (Pl. I, figs. g & h). The narrow form is often separated as var. *tenuissima,* but as in *M. granulata* it may be only a growth form.

MALAYA Perak: Taiping Lakes.
Selangor: Common in fish-ponds.
Negri Sembilan: Common in fish-ponds.
Malacca: Common in fish-ponds.
Singapore: Common in fish-ponds; Botanic Gardens Lake.

Distribution worldwide.

3. **Melosira roeseana** Rabenhorst. [Syn.: *Orthosira spinosa* Grev.; *Melosira spinosa* (Grev.) Bréb.]. Cells 16–20μ long × 20–30μ diameter; sulcus wide, concave and rounded; valve with prominent marginal teeth; valve view with punctae in radial striation with 1–4 central spots; girdle view finely punctate, the punctae being finer and closer together in the central area of

the girdle, the striae being parallel and straight, 15–20 in 10μ in the central area of the girdle, 10–15 in 10μ nearer the valve edges. (Pl. I, figs. c & i).

MALAYA Selangor: Gombak River, rare.

Found in moorland bogs and waterfalls in Europe, Indonesia and the Philippines, and probably elsewhere in Asia.

4. **Melosira ruettneri** Hustedt. Cells 34–38μ long × 25–26μ diameter; sulcus absent, the wall being straight, but in the middle forming a pseudosulcus; cell wall very thick, thinner near the centre of the valve and at the pseudosulcus, and composed of two membranes, the outer irregularly areolate, with the areolae smaller towards the centre of the girdle, and towards the centre of the valve, the inner very finely punctate, the punctae being in radial striae on the valve face, and spiral on the girdle view; pseudosulcus smooth. (Pl. I, fig. d).

MALAYA Selangor: Feeder stream to Klang Gates Reservoir, rare.

Recorded from Indonesia.

CYCLOTELLA Kuetzing 1834

Cells discoid or drum shaped, solitary or colonial within a mucilaginous envelope; when filamentous the cells not tightly interlocking as in Melosira; valve view circular, or sometimes elliptic; ornamentation of the valve in two very distinct concentric regions, the outer zone radially striate or punctate, the inner zone smooth, or irregularly and finely punctate; girdle view straight or undulate; chromatophores numerous, small and discoid.

Auxospores formed singly within a cell; some species known to be autogamous.

5. **Cyclotella kuetzingiana** Thwaites. Cells 10–28μ in diameter, outer zone with fine radial striae, 15–18 in 10μ about ¼ diameter in length; inner zone with a few fine, scattered punctae. (Pl. II, figs. i & j).

MALAYA Pahang: A stream near Kuantan.

Distribution widespread in freshwaters.

6. **Cyclotella meneghiniana** Kuetzing. Cells 10–25μ in diameter; outer zone broad, with thick well-marked striae, 7–9 in 10μ; central zone smooth, or with fine radial striae. (Pl. I, fig. e; Pl. II, fig. h). The form with a smooth central zone is sometimes separated as var. *rectangulata* Grun.

MALAYA Selangor: Common in fish-ponds.
Negri Sembilan: Common in fish-ponds.
Malacca: Common in fish-ponds.
Singapore: Common in fish-ponds; Botanic Gardens Lake.

Widespread in distribution.

7. **Cyclotella striata** (Kuetzing) Grunow. [Syn. *Coscinodiscus striatus* Kuetzing.]. Cells 25–40μ in diameter; outer zone broad with well marked striae, 10–12 in 10μ, every second or third stria marked with a prominent pore; sometimes very short, fine, marginal striae in between the long ones; at a deeper focus submarginal curves often visible between the pores; inner zone with irregular swellings, matt in texture. (Pl. I, fig. f; Pl. II, figs. b & g).

MALAYA Pahang: A stream near Kuantan.
Malacca: Non-saline water of Malacca River.

Widespread, marine in coastal waters and in estuaries in Europe, Asia and America.

COSCINODISCUS Ehrenberg 1838

Cells discoid, solitary or sometimes forming short, very loose mucilaginous chains, valve view circular, ornamented with distinct areolae, which may be radial, tangential or somewhat irregularly arranged, the ornamentation forming one zone only; marginal teeth present or absent. Mainly a marine genus.

8. **Coscinodiscus antiquus** (Grunow) A. Cleve. Cells 60–80μ in diameter; areolae large, polygonal of equal size except at margin, arranged excentrically, on lines curving away from the centre, sometimes almost tangential; marginal teeth absent; marginal striae marked, 6–10 in 10μ. (Pl. II, fig. f).

MALAYA Malacca: Malacca River in non-saline water.

Marine in origin, widespread in coastal water in Europe and America.

9. **Coscinodiscus argus** Ehrenberg. Cells 70–100μ in diameter; areolae large, polygonal, each with a prominent central pore; arranged in a close network, not markedly radial; areolae smaller towards the centre and near the margin; some tendency for the areolae to lie on lines spiralling towards the centre, marginal region small, hardly distinguishable from the sub-marginal areolae; marginal teeth absent. (Pl. I, figs. j, l & m).

MALAYA Pahang: A stream near Kuantan.

Marine in origin, widespread.

10. **Coscinodiscus decipiens** Grunow. [Syn. *Thalassiosira decipiens* (Grun.) Joerg.]. Cells small, 8–20μ in diameter, forming a short mucilaginous chain; valve flat, areolae roundish to polygonal, very excentric, in lines curving away from the centre; inner areolae larger, decreasing in size towards the margin; submarginal teeth prominent. (Pl. III, fig. c).

MALAYA Pahang: A stream near Kuantan, together with desmids.

Marine in origin, widespread in coastal waters.

11. **Coscinodiscus divisus** Grunow. Cells 30–50μ in diameter; valves flat; areolae small, polygonal, arranged in bundles, lines in each bundle parallel to one side and crossed by lines curving towards the centre; marginal zone with fine areolae, about 12–18 in 10μ; a very small spine opposite each bundle. (Pl. II, figs. a & d). This species is very characteristic, with the radial lines parallel to one side of each bundle.

MALAYA Malacca: Malacca River in non-saline water.

Distribution widespread, marine or brackish water.

12. **Coscinodiscus excentricus** Ehrenberg. Cells 20–40μ in diameter, discoid; valve flat; areolae small of equal size, arranged excentrically in lines curving away from the centre; teeth in a marginal ring. (Pl. III, fig. e). This is much smaller than the typical form, but obviously belongs under this species.

MALAYA Pahang: A stream near Kuantan, in non-saline water.

Marine in origin, widespread.

13. **Coscinodiscus griseus** Greville var **gallopagensis** Grunow. Cells 30–40μ in diameter; valves concentrically undulate; areolae small, resembling pores, arranged in radiating rows sometimes crossed by spiral rows; inner rows widely set apart about 6–9 in 10μ, outer ones much closer, or smaller areolae forming marginal striations; marginal teeth absent. (Pl. II, fig. e).

MALAYA Pahang: A stream near Kuantan.

Marine in origin.

14. **Coscinodiscus lineatus** Ehrenberg. Cells large, 80–120μ in diameter; areolae large, hexagonal, more or less equal in size, arranged in linear rows parallel to the diameter 4–5 in 10μ, except near the margin, where the areolae are smaller and irregular; margin wide, striae 10–12 in 10μ; smaller teeth on inner side of margin, about 3 in 20μ. (Pl. I, figs. k & n).

MALAYA Pahang: A stream near Kuantan.
Malacca: Malacca River.

Marine, widespread.

15. **Coscinodiscus lineatus** Ehrenberg var. **van heurckii** P. T. Cleve. Very much smaller than the type, only 15–20μ in diameter; areolae arranged in linear rows, 10 in 10μ; marginal teeth absent. (Pl. III, fig. d).

MALAYA Pahang: A stream near Kuantan.

Marine in origin.

16. **Coscinodiscus symmetricus** Kitton. Cells 80–90μ in diameter; areolae hexagonal, alike in size, 4–5 in 10μ, arranged in wedge-shaped bundles, the rays of each bundle being parallel symmetrically about the middle line; rays crossed by secondary rays curving towards the centre; margin striate, 9–10 striae in 10μ; teeth absent. (Pl. II, fig. c).

MALAYA Pahang: A stream near Kuantan.
Malacca: Malacca River.

Marine in origin.

THALASSIOSIRA P. T. Cleve 1873

Cells discoid or drum shaped, single or united into chains by a central thread; valves circular very finely ornamented; teeth submarginal, usually very fine, often a single unpaired course tooth. Largely a marine genus.

17. **Thalassiosira fluviatilis** Hustedt. Cells 15–20μ in diameter, drum-shaped, solitary; valve slightly convex, very finely punctate in radial striae, not in bundles, teeth submarginal, fine, 10–12 in 10μ, one much larger unpaired tooth or spine. (Pl. II, fig. k).

MALAYA Pahang: A stream near Kuantan, together with desmids.

Widespread in brackish water, both inland and estuarine.

STEPHANODISCUS Ehrenberg 1845

Cells discoid, drum-shaped or cylindric, single and free-floating, rarely in chains; valves circular, radially punctate and with a ring of short, but stout spines near the margin; girdle view generally somewhat undulate, with smooth surfaces and without intercalary bands, chromatophores several small discs or one or two large irregular flat plates. Largely a marine genus.

18. **Stephanodiscus biserialis** Prowse **sp. nov.** Cells drum-shaped, valves circular, 40–50μ in diameter, hollowed in the middle, striae in two series, the outer series finely punctate, 11–12 in 10μ, about one-third radius long, inner series prominent, highly refractive, punctae not visible, each stria a continuation of every alternate outer stria into the hollowed centre, about one-third radius long, outer striae not joined in pairs to inner striae as in *S. astraea;* central area apparently quite smooth; submarginal spines short, prominent, 3½ in 10μ (Pl. III, fig. a).

MALAYA Pahang: A stream near Kuantan. (Type locality).

Holotype No. Prowse 582a is deposited at the Tropical Fish Culture Research Institute, Malacca, Federation of Malaya.

Frustula cylindrica, altitudine brevissima. Valvae orbiculares, 40–50μ in diam., medio concavae. Striae biseriatae, in serie exteriore minute punctatae, 11–12 in 10μ circa tertiam radii partem longae, cum interioribus pariter ut in *S. astraea* non jugatae; striae interiores singulae ex unisquibusque striis alternatis exterioribus orientes, circam tertiam radii partem longae. Area centralis laevissima ut videtur; spinis submarginalibus brevibus, prominentibus, 3½ in 10μ.

MALAYA Pahang, in fluvio proximo urbe Kuantan.

19. **Stephanodiscus fenestralis** Prowse **sp. nov.** Cells drum-shaped; valves circular, 40–50μ in diameter, hollowed in the middle; striae 12–14 in 10μ, about half the radius in length, reaching to the edge of the central hollow where they meet the upper edges of the sub-central rectangular refractive "windows" or depressions, each about 5 striae wide and lying 3–4 striae apart on the sloping sides of the central hollow; spaces between the "windows" and the central area of the hollow apparently quite smooth; submarginal spines short, prominent, 3–4 in 10μ. (Pl. III, fig. b).

MALAYA Pahang: A stream near Kuantan. (Type locality).

Holotype No. Prowse 582b is deposited at the Tropical Fish Culture Research Institute, Malacca, Federation of Malaya.

Frustula cylindrica, longitudinae brevissima. Valvae orbiculares, 40–50μ in diam., medio late concavae. Striae 12–14 in 10μ, fere semi-radiales, inter extremitates earum ac cavi marginem centralis caveolulis rectangularibus, refractivis, singulis 5-striae latis, 3–4 striae inter se remotis, in modum fenestrarum dispositis; loculi inter caveolulas et cavus centrales laevissimi ut videtur. Spinae submarginales breves, prominentes, 3–4 in 10μ.

MALAYA Pahang, in fluvio proximo urbe Kuantan.

CHAETOCEROS Ehrenberg 1844

Cells cylindrical, elliptical or circular in valve view, in girdle view rectangular with plane, concave or slightly convex ends; intercalary bands present; cells united in chains, rarely single; each valve bearing two long fine hair like spines which intersect with those of the neighbouring cell; chromatophores small, discoid and numerous. Auxospores formed singly in each cell. Mainly a marine genus.

20. **Chaetoceros amanita** A. Cleve. Cells in girdle view rectangular 8–12μ high × 15–20μ in widest width, sides straight, end walls curved, separated by lanceolate openings; valve view elliptical; spines long and slender, not differing markedly on

end cells; auxospore with a large primary valve and a smaller secondary valve, both ornamented with short spines. (Pl. III, figs. g & h).

The characteristically shaped auxospore makes it certain that the Malayan specimens belong to this species.

MALAYA Pahang: A stream near Kuantan together with desmids.

Distributed in brackish waters in Europe and the Middle East.

RHIZOSOLENIA Ehrenberg 1843; emend. Brightwell 1858

Cells elongate cylinders, with many intercalary bands, and circular or elliptical in cross-section, free-floating, solitary or sometimes in straight or spirally twisted chains; end of valve calyptra-like, terminating apically in a long centric or excentric spine; walls very finely punctate or without markings, silicification slight; chromatophores small, discoid and scattered. Reproduction by auxospores, statopores and microspores. Mainly marine.

21. **Rhizosolenia eriensis** H. L. Smith. Cells cylindrical, slightly flattened, 5–15μ wide × 40–150μ long; intercalary bands scale-like and imbricated 2–4 in 10μ; valve end calyptra like, each terminating asymmetrically in a single long spine, shorter in length than the length of the cell body. (Pl. III, fig. f).

MALAYA Malacca: Batu Berendam, in fish-ponds at the Tropical Fish Culture Research Station.

Widespread in lakes in Europe, America and in Indonesia.

II. ORDER PENNALES

Cells solitary or variously united into ribbon like, stellate, zig-zag, dendroid or irregular colonies, free-floating, or attached by gelatinous stalks or by other mucilaginous secretions; valves elongate, rarely nearly round, bilaterally symmetric about a median longitudinal line, not radiating from a central point; pseudoraphe or raphe present, if raphe present, cells possess the property of mobility; valves without marginal spines or projections, rarely winged; chromatophores variable, small and discoid, or larger and laminate with pyrenoids; auxospores formed by the conjugation of two cells, or autogamously; vegetative cells diploid.

Key to Pennales

(i) Cells with no true raphe; pseudoraphe on both valves (ii)

(i) Cells with a very short raphe at each end .... (iii)

(i) Cells with one valve bearing a true raphe, the other with only a pseudoraphe .... (iv)

(i) Both valves bearing true raphes .... (v)

(ii) Valves usually narrow and much elongated; cells solitary or in tufted fan-shaped colonies .... 9. *Synedra*

(ii) Valves usually broader; cells in ribbons, zig-zag bands or stellate colonies, rarely solitary .... 8. *Fragilaria*

(iii) Cells usually in ribbons; no denticulations on valve edges 10. *Eunotia*

(iii) Cells in branched dendroid colonies, joined end to end; valves with fine denticulations at edge 11. *Desmogonium*

(iv) Valves elliptic to nearly circular; cells transversely curved in girdle view .... 12. *Cocconeis*

(iv) Valves more elongated; cells longitudinally curved in girdle view .... 13. *Achnanthes*

(v) Raphe in a distinct keel or wing .... (vi)

(v) Raphe not in a keel or wing .... (ix)

(vi) Keel usually attached to one lateral margin of each valve, rarely central, and with a row of circular pores (carinal dots) .... (vii)

(vi) Keel not attached to valve margin, but straight, sigmoid or excentric to the median longitudinal line, no carinal dots 28. *Tropidoneis*

(vi) Keel usually wing-like attached to both margins of each valve; valve face distinctly costate .... (viii)

(vii) Both valves having the keel attached on the same adjacent side .... 29. *Hantzschia*

(vii) Valves having the keels attached on opposite sides 30. *Nitzschia*

(viii) Valve view nearly circular in outline, often bent 33. *Campylodiscus*

(viii) Valve view ovate, elliptic or nearly linear ... 32. *Surirella*

(viii) Valve view distinctly linear, sigmoid .. 31. *Stenopterobia*

(ix) Valve view more or less symmetrical about the median longitudinal line .... (x)

(ix) Valve view not symmetrical about the median longitudinal line .... (xviii)

(x) Valve view and girdle view usually symmetrical about the median transverse line . . . . (xi)

(x) Valve and girdle view not symmetrical about the median transverse line; one pole usually wider than the other 26. *Gomphonema*

(xi) Raphe enclosed between parallel ribs or horns extending from central nodule . . . . (xii)

(xi) Raphe not enclosed between ribs . . . . (xiii)

(xii) No longitudinal furrow outside ribs, transverse striations finely punctate, not costate . . . . 14. *Frustulia*

(xii) Longitudinal furrow on each side of ribs; transverse striations costate or coarsely punctate . . . . . . 19. *Diploneis*

(xiii) Valve with transverse costae opening inwards; raphe complex, often curved . . . . 23. *Pinnularia*

(xiii) Valves punctate; if costate, costae showing punctae and not opening inwards; raphe usually much simpler . (xiv)

(xiv) Striae crossed by longitudinal hyaline lines . . . . (xvi)

(xiv) Striae not crossed by hyaline longitudinal lines xv

(xv) Central nodule not reaching margins . . . . . . 22. *Navicula*

(xv) Central nodule reaching both margines . . . 20. *Stauroneis*

(xvi) Longitudinal lines parallel to and near the lateral margins (xvii)

(xvi) Longitudinal lines not parallel to lateral margins but zigzagging and coalescing in places . . . . 21. *Anomoeoneis*

(xvii) Raphe bifurcate at poles and curving in opposite directions at central nodule . . . . 18. *Neidium*

(xvii) Raphe not bifurcate at poles and straight or only slightly curved in same direction at central nodule . 17. *Caloneis*

(xviii) Valve view distinctly sigmoid . . . . (xix)

(xviii) Valve view curved to one side, lunate or sickle-shaped . (xx)

(xix) Transverse striations crossed by longitudinal lines 15. *Gyrosigma*

(xix) Transverse striations cut by crossed lines at an angle 16. *Pleurosigma*

(xx) Cells in girdle view with parallel sides, more or less rectangular . . . . 25. *Cymbella*

(xx) Cells in girdle view with outer margins convex . . . . (xxi)

(xxi) Transverse striations separated by costae . 27. *Rhopalodia*

(xxi) Transverse striations without costae . . . . . . 24. *Amphora*

FRAGILARIA Lyngbye 1819, Rabenhorst 1864

Cells united into free-floating or sessile colonies, mostly zig-zag chains or ribbons, sometimes flat, stellate colonies; cells rectangular in girdle view, with one or two intercalary bands (sometimes none), without septa or costae; valve view linear to fusiform, bilaterally symmetrical, usually attenuated at the poles, sometimes capitate and often medianly inflated, rarely constricted; transverse striae usually fine, sometimes coarse; pseudoraphe narrow and indistinct to broad and prominent; chromatophores numerous small discoid bodies or one to four laminate plates with pyrenoids.

Auxospores formed singly within the cells.

22. **Fragilaria lapponica** Grunow var. **tetragonalis** Prowse **var. nov.** Valves quadrangular, 45μ long, 40μ wide, with slightly incurved margins. Striae short, thick, marginal, 6–10 in 10μ. (Pl. IV, fig. f).

MALAYA Malacca: Malacca River. (Type locality).

Holotype No. Prowse 183a is deposited at the Tropical Fish Culture Research Institute, Malacca, Federation of Malaya.

Valvae quadrangulares, 45μ longae, 40μ latae, marginibus paulo incurvis. Striae breves, crassae, marginales, 6–10 in 10μ.

MALAYA Malacca, in fluvio.

This is much larger than most forms of the species.

23. **Fragilaria vaucheriae** (Kuetzing) Boye Petersen. [Syn.: *Synedra vaucheriae* Kuetz.; *F. intermedia* Grunow.]. Cells 50–90μ long × 3–6μ wide, forming closely knit ribbons; girdle view linear—rectangular; valve view elongate—lanceolate, narrowed near the ends, capitate; pseudoraphe narrow; transverse striae marked, 9–12 in 10μ, with a clear central area on one side. (Pl. IV, fig. a).

MALAYA Pahang: Cameron Highlands.
Selangor: Gombak River.
Malacca: Malacca River.

Widely distributed in fresh water.

The Malayan specimens are larger than the type, but it is doubtful if this is of varietal significance.

24. **Fragilaria virescens** Ralfs var. **elliptica** Hustedt. Cells 9–15μ long × 5–7μ wide, rectangular in girdle view, elliptic-lanceolate in valve view; pseudoraphe narrow, not very distinct; transverse striae fine, parallel or slightly radiate, 15–20 in 10μ; united in short ribbons. (Pl. IV, fig. d).

MALAYA Pahang: Stream near Kuantan, rare.

Widely distributed in freshwater in several countries, but rare.

SYNEDRA Ehrenberg 1830

Cells narrow and much elongated, solitary or in fan-shaped tufts or radiating colonies, free-floating or epiphytic, sessile or stalked; valves linear to lanceolate, straight or sometimes curved, with poles attenuated or not, often capitate; transverse striations lateral to a conspicuous pseudoraphe, which is usually narrow but sometimes broad; central smooth area present or not; girdle view elongate with truncate ends, striated; chromatophores two large plates, usually with 3 or more pyrenoids in each.

Auxospores 1–2 in each cell, formed without conjugation.

25. **Synedra tabulata** (C.A. Agardh) Kuetzing, var. **acuminata** (Grunow) Hustedt. [Syn.: *Diatoma tabulatum* C.A. Ag., *S. affinis* Kuetzing var. *acuminata* Grun.]. Cells 50–80μ long × 3–5μ wide, lanceolate, narrowed to slightly capitate ends; striae 13–15 in 10μ, shorter than the wide pseudoraphe. (Pl. IV, figs. b & c).

MALAYA Pahang: Stream near Kuantan, together with desmids, not common.

Widely spread in brackish waters in various countries.

26. **Synedra ulna** (Nitzsch) Ehrenberg var. **amphirhynchus** (Ehrenberg) Grunow. [Syn.: *Bacillaria ulna* Nitzs., *S. amphirhynchus* Ehr.]. Cells 150–240μ long × 5–7μ wide, nearly linear, constricted near the poles, which are capitate; pseudoraphe narrow, but well defined, widening in the middle to an elliptic to rectangular, smooth middle area; striae well-marked, 8–10 in 10μ. (Pl. IV, fig. h).

MALAYA Selangor: Fish-ponds.
Negri Sembilan: Fish-ponds.
Malacca: Fish-ponds, Malacca River.
Singapore: Botanic Gardens Lake.

Widespread in freshwaters in various parts of the world.

27. **Synedra ulna** (Nitzsch) Ehrenberg var. **danica** (Kuetzing) Grunow. [Syn.: *Bacillaria ulna* Nitzs., *S. danica* Kuetz., *S. ulna* (Nitzs.) Ehr. var. *chaseana* B. W. Thomas, *S. longissima* W. Smith var. *acicularis* Meister.]. Cells 150–200μ long × 5μ wide; long, narrow linear-lanceolate, slightly narrowing to the poles which are hardly capitate; pseudoraphe narrow but well defined, widening at the centre into a rectangular, clear middle area; striae well-marked, 9–10 in 10μ. (Pl. IV, fig. g).

MALAYA Selangor: Klang River, fish-ponds.
Negri Sembilan: Fish-ponds.
Malacca: Fish-ponds.
Singapore: Botanic Gardens Lake.

Widespread in freshwater.

EUNOTIA Ehrenberg 1837

Cells rectangular to linear in girdle view, both girdles and valves strongly ornamented, usually with inter-calary bands, free floating or epiphytic, solitary or united valve to valve into ribbons or chains; valves arcuate with similar poles but dissimilar margins: concave side regular, convex side regular, or inflated at the poles or undulate, sometimes nearly straight; raphe very short, extending from the fairly evident polar nodule diagonally to the concave margin, no central nodule; neither costae nor septa present; intercalary bands usually present; transverse striations or punctations present, but without marginal denticulations or dots; chromatophores two, laminate, without pyrenoids.

Auxospores single from the conjugation of two cells.

28. **Eunotia camelus** Ehrenberg. Cells rectangular in girdle view, united in ribbons; in valve view 25–30μ long × 5μ wide, distinctly arcuate, with two prominent humps on the convex side; ends narrowed on convex side, rounded—sub-capitate, reflexed away from the concave side, nodules small, sub-terminal; striations 11–14 in 10μ. (Pl. V, figs. y & z).

The two forms figured are more arched and with more prominent humps than the type, and the ends are reflexed. They show a marked resemblance to var. *gibbosa* Gandhi and var. *ventricosa* Gandhi, but are regular and not gibbous on concave margin.

MALAYA Malacca: Malacca River.

Distributed in South-east Asia.

29. **Eunotia camelus** Ehrenberg var. **karveerensis** Gandhi. Cells rectangular in girdle view, united in ribbons; on valve view 35–40μ long × 5–7 wide, strongly arcuate, dorsal edge convex with four strong rounded uniform humps; ends narrowed on dorsal side, produced, rounded, sub-capitate; nodules small, subterminal; striae 11–13 in 10μ. (Pl. V, figs. c & d).

MALAYA Malacca: Malacca River.

Described from India.

A. Berg (1939) has separated the two humped forms as forms of *E. pectinalis* (Kuetz.) Rabh. but there seems no justification for this as the two are unlike *E. pectinalis,* being much less arched, very much less convex on the dorsal side, and with the ends hardly reflexed. Gandhi (1957) has discussed the status of *E. camelus* and I agree with him that both two and four-humped forms should be included as forms of the same species, but unlike him I would take the two-humped forms as the type, since they were so described by Ehrenberg—"E. minoribus, valvus striatis, dorse elati gibbere duplici, ventre concave, apicibus productis attenuatis obtusis." (De Toni, 1889–1924)—and regard the four-humped forms as being varieties.

30. **Eunotia cancellata** A. Berg var. **esseda** A. Berg. Cells small, rectangular in girdle view; in valve view 10–15μ long × 3–4μ wide, only slightly arcuate, nearly straight on ventral margin, except at the ends where it curves down slightly; dorsal margin straight in the middle, curving away to the rounded, sub-capitate ends, shoulders marked; nodules terminal with well marked inner almost central secondary nodules; striae 15–20 in 10μ. (Pl. V, fig. n).

The Malayan form seems to come closest to the variety *esseda* as described and figured by A. Cleve-Euler (1933).

MALAYA Pahang, a stream near Kuantan.

Described from Europe.

31. **Eunotia diodon** Ehrenberg var. **minor** Grunow. Cells rectangular in girdle view; in valve view 35–40μ long × 10–12μ wide, very slightly curved on the ventral margin, much more markedly convex on dorsal side, bi-undulate with a slight depression between the two humps, curving down to the non-capitate ends; nodules, prominent, terminal; striations 13–15 in 10μ, slightly radial. (Pl. V, figs. p & q).

MALAYA Pahang: Cameron Highlands.
Malacca: Malacca River.

Widely distributed.

32. **Eunotia exigua** (Brébisson) Grunow. [Syn.: *Himantidium exiguum* Brébisson]. Valves small, 15–20μ long × 2–3μ wide, linear, slightly arched, both margins parallel in the middle, but the ends rounded-capitate, slightly reflexed to the dorsal margin; nodules terminal; striae fine, 20–24 in 10μ (Pl. V, fig. j).

MALAYA Pahang: Cameron Highlands.

Widely distributed.

33. **Eunotia faba** (Ehrenberg) Grunow var. **densestriata** Oestrup. [Syn.: *Himantidium faba* Ehr.]. Cells small, rectangular tabular in girdle view; in valve view 13–15μ long × 3–4μ wide, slightly arched, subconcave on the ventral margin, slightly more curved on the dorsal margin; ends rounded, hardly capitate; nodules terminal; striae 19–20 in 10μ. (Pl. V, fig. m).

MALAYA Pahang: Cameron Highlands.

Widely distributed.

34. **Eunotia flexuosa** Kuetzing. Cells linear in girdle view; in valve view 120–270μ long × 3–5μ wide, linear, straight or slightly broadened; nodules terminal with a short pseudoraphe extending inwards; transverse striations finely punctate, 12–18 in 10μ. (Pl. VI, figs. b & c).

MALAYA Pahang: Cameron Highlands.
Malacca: Swamps.
Singapore.

35. **Eunotia formica** Ehrenberg. Cells rectangular in girdle view; in valve view 40–130μ long × 10–14μ wide, with parallel margins, ends cuneate making the whole valve resemble a bone in appearance; nodules terminal, with a long pseudoraphe extending inwards from it parallel to the sides; striations 9–14 in 10μ, somewhat irregular, punctate. (Pl. VI, figs. g & h).

Malaya Pahang: Cameron Highlands.
Selangor: Gombak River.
Malacca: Malacca River.

Widely distributed.

36. **Eunotia gracilis** (Ehrenberg) Rabenhorst. [Syn.: *Himantidium gracilis* Ehr.]. Cells in girdle view rectangular; in valve view, 80–110μ long × 4–6μ wide, linear with parallel sides, distinctly curved; ends rounded, slightly capitate, nodules terminal; transverse striae 12–16 in 10μ. (Pl. VII, fig. b).

Malaya Malacca: Malacca River.

Widespread in distribution.

37. **Eunotia grunowi** A. Berg var. **uplandica** A. Cleve f. **subundulata** A. Cleve. [Syn.: *E. pectinalis* var. *stricta* (Rabenhorst) Grunow forma]. Cells rectangular in girdle view; in valve view 50–70μ long × 8–10μ wide, slightly curved, dorsal side more convex than ventral side with marked shoulders, slightly incurved in the middle; ends rounded, sub-capitate; nodules terminal; transverse striae 10–13 in 10μ. (Pl. V, fig. e).

Malaya Malacca: Malacca River.

Recorded from Scandinavia.

The form found in Malaya comes nearest to that described by A. Cleve-Euler (1953).

38. **Eunotia lunaris** (Ehrenberg) Grunow. [Syn.: *Synedra lunaris* Ehr.]. Cells linear in girdle view; in valve view 45–80μ long × 3–4μ wide, linear with parallel sides, curved forming a wide arc, slightly thinner at the poles; nodules terminal, small; transverse striae 14–18 in 10μ. (Pl. V, fig. f).

Malaya Pahang: Cameron Highlands.

Widespread in distribution.

39. **Eunotia lunaris** (Ehrenberg) Grunow var. **capitata** Grunow. Differing from the type in that the ends are capitate and slightly reflexed; in valve view 40–80μ long × 4–5μ wide; transverse striae 15–16 in 10μ. (Pl. V, fig. h).

Malaya Malacca: Malacca River.

Widespread in distribution.

40. **Eunotia major** (W. Smith) Rabenhorst var. **emarginata** A. Cleve. [Syn.: *Himantidium majus* W. Smith, *E. major* (W. Smith) Rabh. var. *bidens* (Greg.) A. Cleve.]. Cells in girdle view rectangular; in valve view 60–100μ long × 10–12μ wide; broadly curved, with slightly cuneate, rounded ends, the dorsal side with two broad flattish humps; nodules terminal; transverse striae somewhat irregular, 10–12 in 10μ. (Pl. VI, fig. f).

MALAYA Perak: Taiping lakes.

Described from Europe.

41. **Eunotia major** (W. Smith) Rabenhorst var. **indica** Grunow. [Syn.: *Himantidium majus* W. Smith, *E. indica* Grun.]. Cells rectangular in girdle view; in valve view 70–90μ long × 10μ wide, curved, with both margins parallel in the middle but curving down on the dorsal side to the sub-capitate, slightly cuneate, ends; nodules terminal; transverse striae 8–12 in 10μ, irregularly distributed. (Pl. V, fig. i).

MALAYA Malacca: Malacca River.

Described from India and from Sweden, and is probably widely distributed.

42. **Eunotia major** (W. Smith) Rabenhorst var. **linearis** A. Cleve. [Syn.: *Himantidium majus* W. Smith, *E. monodon* Ehr. var. *major* Hust.]. Cells rectangular in girdle view; in valve view 120–150μ long × 10–12μ wide, broadly curved with parallel sides; ends rounded, slightly wider; nodules terminal, prominent; transverse striae 8–10 in 10μ. (Pl. VII, fig. a).

MALAYA Malacca: Malacca River.

Distribution widespread.

43. **Eunotia monodon** Ehrenberg var. **alpina** Kuetzing. Cells small, 20–25μ long × 5μ wide in valve view, slightly curved, concave on the ventral side, slightly more convex on the dorsal side, narrowing gently to the rounded, hardly reflexed ends; nodules terminal, small; striae 14 in 10μ. (Pl. V, fig. s).

MALAYA Pahang: Stream near Kuantan.

Distributed in Europe, possibly elsewhere.

44. **Eunotia monodon** Ehrenberg var. **constricta** A. Cleve-Euler. [Syn.: *E. major* (W. Smith) Rabh. v. *hybrida* f. *bidens* A. Cleve]. Cells rectangular in girdle view; in valve view 65–70μ long × 10–15μ wide, broadly arcuate, with two broad swellings on the dorsal margin, slightly reflexed before the rounded, slightly cuneate ends; nodules terminal, prominent; striae 10–12 in 10μ. (Pl. V, fig. a).

MALAYA Malacca: Fish-ponds at Jasin and Malacca.

Probably widespread in distribution.

45. **Eunotia monodon** Ehrenberg var. **undulata** A. Cleve-Euler. [Syn.: *E. major* (W. Smith) Rabh. var. *undulata* A. Berg]. Cells in girdle view rectangular; in valve view 65–70μ long × 8–10μ wide, broadly arcuate, with the dorsal margin more convex and with four broad, flattish, equal humps; ends narrower, rounded, not markedly capitate; nodules terminal, small; transverse striae 10–12 in 10μ. (Pl. V, fig. g).

MALAYA Malacca: Malacca River.

Distributed in Europe and probably elsewhere; not common.

This certainly comes nearest to Cleve-Euler's figure and description (1953), but it may possibly belong to another species.

46. **Eunotia pectinalis** (Kuetzing) Rabenhorst. [Syn.: *Himantidium pectinalis* Kuetzing.]. Cells rectangular-tabular in girdle view, in valve view 40–80μ long × 5–8μ wide, linear, slightly curved, the dorsal margin parallel to the ventral margin, narrowing slightly at the ends to the rounded slightly reflexed but non-capitate poles; nodules terminal, small, transverse striae 9–11 in 10μ, well-marked. (Pl. V, fig. b).

MALAYA Pahang: Cameron Highlands.
Malacca: Widespread.

Widespread in distribution.

47. **Eunotia pectinalis** (Kuetzing) Rabenhorst var. **minor** (Kuetzing) Rabenhorst. [Syn.: *Himantidium pectinalis* Kuetz. var. *minor* Kuetz.]. Much smaller than the type, 15–20μ long × 1.5–2μ wide. (Pl. V, fig. w).

MALAYA Pahang: Cameron Highlands.

Widespread in distribution.

48. **Eunotia polydentula** (Brun) emend. A. Berg var. **perminuta** (Grunow) A. Berg. [Syn.: *E. tridentula* Ehr. var. *perminuta* Grun.]. Cells small, 10–20μ long × 3–4μ wide, slightly arcuate with roughly parallel margins, the dorsal side with 3–4 shallow swellings; ends a little narrower, capitate and slightly reflexed; nodules terminal; transverse striae 16–20 in 10μ. (Pl. V, figs. u & v).

MALAYA Pahang: Cameron Highlands.
Johore: Ayer Hitam.

Described from Europe but probably more widely distributed.

49. **Eunotia praemonos** A. Cleve-Euler var. **inflata** (Grunow) A. Cleve-Euler. [Syn.: *E. praerupta* Ehr. v. *inflata* Grun.]. Cells small, 15–30μ long × 5–7μ wide, ventral side hardly concave, nearly straight, dorsal side much more convex; ends broadly rounded, slightly reflexed; nodules terminal, well-marked; transverse striae coarse, irregularly arranged, 7–13 in 10μ. (Pl. V, figs. r & l).

MALAYA Pahang: Stream near Kuantan.

Described from Europe but doubtless more widespread.

50. **Eunotia praemonos** A. Cleve-Euler var. **monodon** (Oestrup) A. Cleve-Euler. [Syn.: *E. praerupta* Ehr. var. *curta* Grun. forma *monodon* Oest., *E. praerupta* Ehr. var. *monodon* Oest.]. Cells small, 20–25μ long × 7–8μ wide; ventral side slightly concave, dorsal side with a marked central wedge-shaped swelling; ends broadly rounded, only very slightly capitate; nodules terminal, well marked; striae coarse, 10–12 in 10μ. (Pl. V, fig. k).

MALAYA Pahang: Stream near Kuantan.

Described from Europe but probably occurs elsewhere.

51. **Eunotia praemonos** A. Cleve-Euler var. **tibetica** (Mereschkowski) A. Cleve-Euler. [Syn.: *E. praemonos* A. Cleve-Euler forma *tibetica* A. Berg, *E. praerupta* var. *tibetica* Mereschkowski *E. praerupta-monos* A. Berg forma *undata* A. Berg, *E. praerupta* var. *bidens* Hust.]. Cells rectangular-tabular in girdle view; in valve view 25–35μ long × 7–9μ wide, arcuate with two broad humps on the dorsal side, the ends parallel, very bluntly rounded poles, almost truncate; nodules small, terminal; transverse striae irregular with some short ones on the dorsal margin, 10–14 in 10μ. (Pl. VI, fig. i).

MALAYA Malacca: Malacca River.

Described from Tibet and Scandinavia but doubtless occurs elsewhere.

Despite the difference in habitat the Malayan forms seem to fit under no other variety, and any differences are too slight to justify their separation under a new form.

52. **Eunotia robusta** Ralfs. Cells large, in girdle view rectangular-tabular; in valve view 65–100μ long × 9–18μ wide, broadly linear, arcuate, with 4–9 broad swellings on the dorsal side; poles broadly rounded; nodules terminal, distinct; transverse striae coarse, punctate, irregular, 9–12 in 10μ. (Pl. VI, figs. a, d & e).

MALAYA Malacca: Malacca River.

Widespread in distribution.

This species is unmistakable, despite the wide variation in the number of dorsal humps.

53. **Eunotia sarekensis** A. Cleve-Euler var. **minor** A. Cleve-Euler. [Syn.: *E. papilio* (Grunow) P. T. Cleve forma *minor* Hustedt.]. Cells small, rectangular in girdle view; in valve view 20–30μ long × 9–12μ wide, arcuate with the dorsal side prominently raised into two humps, shoulders sharp, sloping suddenly; ends with almost parallel sides, poles bluntly rounded; nodules terminal; transverse striae very irregular with many short ones, 11–14 in 10μ. (Pl. V, fig. o).

MALAYA Pahang: Cameron Highlands.

Described from Europe.

54. **Eunotia sudetica** O. Mueller var. **incisa** (Mayer) A. Cleve-Euler. [Syn.: *E. pectinalis* (Kuetz.) Rabh. var. *incisa* Mayer]. Cells in valve view 15–25μ long × 7–10μ wide; ventral margin almost straight, dorsal margin markedly convex, ends slightly reflexed to the ventral side making a small depression or nick near each end of the ventral margin; poles rounded; nodules small, terminal; transverse striae slightly radial, 10–14 in 10μ. (Pl. V, figs. t & x).

MALAYA Pahang: Stream near Kuantan.

Described from Europe.

DESMOGONIUM Ehrenberg 1848

Cells united end to end forming branching chains, or often dendroid colonies. In girdle view usually linear, in valve view linear. Raphe short in terminal nodules; transverse striae distinct; margins with small granules or denticulations, often difficult to see.

55. **Desmogonium rabenhorstianum** Grunow. Cells joined end to end, often in pairs or fours, forming characteristic branched chains or dendroid colonies; in girdle view linear with slightly swollen ends; in valve view 100–200μ long × 5–8μ wide, linear, slightly arcuate, with rounded, slightly capitate poles; nodules terminal with a small pseudo-nodule in the middle of each end; striae 13–16 in 10μ, each alternate one with a small granule or denticulation at each end. (Pl. VII, figs. c & d). The marginal granules are often difficult to see, showing up only under the highest powers of phase contrast. The characteristic habit of the colonies is enough to distinguish the species.

MALAYA Perak: Taiping.

Pahang: Cameron Highlands, and in several coastal streams.

Selangor: Gombak River.

Negri Sembilan: Port Dickson.

Malacca: Swamps.

Johore: Yong Peng.

Singapore.

Distributed in South-east Asia.

COCCONEIS Ehrenberg 1835; Grunow 1868

Cells transversely curved in girdle view, solitary, epiphytic upon submerged aquatic plants; septa incomplete and intercalary bands absent; valve view elliptic, epivalve with an axial pseudoraphe, hypovalve with a median true raphe which is straight or sigmoid, with central and polar nodules; transverse striae often in distinct punctate rows; chromatophores single, laminate, usually adjoining the epivalve, with one or two pyrenoids.

Auxospores single from two conjugated cells, or formed parthenogenetically from a single gamete.

56. **Cocconeis feuerbornii** Hustedt. Valves elliptic with broadly rounded ends, 20–25μ long × 10–13μ wide; epivalve with a narrow, linear pseudoraphe, striae radial, 17 in 10μ in the middle, 20–25 in 10μ near the poles, punctate with the inner punctae more widely spaced forming wavy longitudinal lines; hypovalve with a linear raphe, axial area narrow linear widening suddenly in the middle to form a stauros reaching half-way to the lateral margins, striae radial, 20–23 in 10μ in the middle, the punctae closer together and more evenly spaced than in the epivalve. (Pl. VIII, figs. k & l).

MALAYA Malacca: Malacca River.

Described from Indonesia.

57. **Cocconeis thumensis** Mayer. Valves elliptic with broadly rounded ends, 13–20μ long × 5–8μ wide; epivalve with broad lanceolate to nearly straight pseudoraphe, striae radial, 12–15 in 10μ coarsely punctate; hypovalve with linear raphe and narrow linear axial area, striae radial 12–15 in 10μ, coarsely punctate. (Pl. IV, figs. t & u).

MALAYA Malacca: Malacca River.

Reported from Europe and Africa, probably widespread in distribution.

There is some variation in this species, the two examples illustrated being the extremes with many intermediates. There seems no justification for separating the longer forms under a varietal name.

ACHNANTHES Bory 1822

Cells in girdle view rectangular, bent or curved longitudinally, usually attached by gelationous stalks, or sessile and united in bundles at the valves, rarely into filaments, occasionally free-floating and solitary; valve-view generally linear-lanceolate, or elliptic; hypovalve usually concave with raphe, a distinct central nodule and less distinct polar nodules, the central area sometimes transversely widened into a stauros; epivalve generally convex, with a pseudoraphe; transverse striations often somewhat radiate, in some species costate; chromatophores one, two or numerous and discoid. Two auxospores formed from two cells by the conjugation of two pairs of gametes.

58. **Achnanthes brevipes** C. A. Agardh var. **intermedia** Kuetzing. Cells in girdle view rectangular, 38–40μ long × 11–12μ wide, distinctly bent longitudinally, with marginal rows of very coarse punctae, costate in appearance, the concave margin broken in the middle by a large hyaline space, four longitudinal rows of coarse punctae down the middle, marginal striae 10–11 in 10μ; valve view linear-lanceolate with a very slight constriction in the middle, epivalve with a linear pseudoraphe excentrically placed, striae costate, 10–11 in 10μ, very coarsely punctate; hypovalve with a linear raphe, axial area linear, widening in the middle to form a stauros, striae costate, 10–11 in 10μ, very coarsely punctate. (Pl. VIII, figs. h–j).

MALAYA Selangor: Feeder stream to the Klang Gates reservoir.

Widespread in distribution.

59. **Achnanthes crenulata** Grunow. Cells in girdle view rectangular, longitudinally bent; in valve view linear-lanceolate, 50μ long × 13–15μ wide, margin distinctly wavy; epivalve with a linear pseudoraphe near one margin, striae 9–10 in 10μ, coarsely punctate, punctae 9–10 in 10μ; hypovalve with raphe, axial area narrow lanceolate widened in the middle to form a stauros reaching the lateral margins, striae 9–10 in 10μ, coarsely punctate, punctae 9–10 in 10μ. (Pl. IV, fig. v).

MALAYA Selangor: Gombak River.

Described also from Perak and Indonesia.

60. **Achnanthes exigua** Grunow. Valves quadratic-elliptic to linear-elliptic, subrostrate, 8–10μ long × 4–5μ wide; epivalve with median linear pseudoraphe, striae slightly radial, 22 in 10μ; hypovalve with raphe, axial area narrow, linear, widened in the middle to form a stauros, striae slightly radial, 25 in 10μ, with one short stria opposite each limb of the stauros. (Pl. IV, fig. 1).
MALAYA Selangor: Feeder stream of the Klang Gates reservoir.
Widespread in distribution.

The small form described is much less rostrate than usual and resembles closely the form figured by A. Cleve-Euler (1953) as 544 a & b and called "forma typica." Ruth Patrick (1936) has recorded the rostrate form from Perak.

61. **Achnanthes hauckiana** Grunow var. **rostrata** Schultz. Valves lanceolate, 17–18μ long × 6–7μ wide, rostrate with rounded poles; epivalve with a linear lanceolate pseudoraphe, striae 12–14 in 10μ prominent, radial, punctae faint; hypovalve with raphe, axial area narrow lanceolate slightly widened in the middle, striae 12–14 in 10μ, prominent, radial punctae faint. (Pl. IV, fig. w).

MALAYA Pahang: Stream near Kuantan.

Widespread, usually in brackish waters.

62. **Achnanthes lanceolata** (Brébisson) Grunow. [Syn.: *Achnanthidium lanceolatum* Brébisson.]. Valves elliptic-lanceolate 15–20μ long × 7–8μ wide, with bluntly rounded ends, hardly narrowed below the poles; epivalve with a linear pseudoraphe and marked, punctate, transverse striae, 12–14 in 10μ, radial and with a prominent refractive gap in the middle of one side; hypovalve with a straight raphe and linear to narrow lanceolate central area, striae prominent, punctate, 12–14 in 10μ, radial and with a gap in one side corresponding to that of the epivalve, but not refractive. (Pl. IV, fig. r).

MALAYA Pahang: Cameron Highlands.

Widespread in freshwaters.

63. **Achnanthes lanceolata** (Brébisson) Grunow var. **rostrata** Hustedt. Differs from the type in being distinctly rostrate to subcapitate at the poles, 15–20μ long × 7–9μ wide; pseudoraphe of epivalve linear, striae less marked, punctate, 12–14 in 10μ, with refractive gap in middle of one side; axial area of hypovalve narrow linear with small lanceolate central area, striae 12–14 in 10μ, radial, without a gap on one side. (Pl. IV, fig. s).

MALAYA Pahang: Cameron Highlands.

Widespread in freshwaters.

64. **Achnanthes stauroneiformis** Prowse. **sp. nov.** Frustules oblong-lanceolate, with linear-rostrate poles, truncate at both ends, 30–32μ long × 25–26μ wide; epivalve with a linear, cruciform pseudoraphe having the transverse arms reaching nearly to the margins, striae 16 in 10μ, distinctly punctate, those opposite the lobes of the stauros being short, marginal 3 on each side; hypovalve similar but with a very distinct raphe, striae closer together, 18–20 in 10μ, punctate, striae opposite the lobes of the stauros short, marginal, 4–5 on each side. (Pl. IV, fig. q).

MALAYA Malacca: Malacca River. (Type locality).

This species closely resembles *Stauroneis* except that only one valve bears a raphe.

Holotype No. Prowse 124a is deposited at the Tropical Fish Culture Research Institute, Malacca, Federation of Malaya.

Frustula oblongo-lanceolata, apice utrinque lineari-rostrata, truncata, 30–32μ longa, 25–26μ lata. Epivalva cum pseudoraphe lineari cruciformi, lobis transversalibus fere ad margines utrinque attingentibus; striae 16 in 10μ, conspicue punctatae, in stauri lobis breves marginales utrinque 3. Hypovalva consimilis, sed raphen clarissimam ferens; striae magis approximatae, 18–20 in 10μ, punctatae, striae in stauri lobis breves marginales utrinque 4–5.

MALAYA Malacca: in flumine principali frequens.

65. **Achnanthes subhudsonis** Hustedt. Valves lanceolate, 10–15μ long × 3–4μ wide, with acute poles; epivalve with narrow linear pseudoraphe, transverse striae fine, 16–17 in 10μ, lightly radial; hypovalve with straight raphe and lanceolate axial area, transverse striae fine, 18 in 10μ. (Pl. IV, fig. e).

MALAYA Pahang: Cameron Highlands.

Described from East Africa.

66. **Achnanthes tenuissima** Hustedt. Valves linear to rhombic-lanceolate, 18–20μ long × 3μ wide, with narrow rounded poles; epivalve with a broad lanceolate pseudoraphe, striae short, marginal, very fine, 28–34 in 10μ, slightly radial; hypovalve with a straight raphe and narrow linear axial area, striae very fine, 32–36 in 10μ, parallel. (Pl. IV, fig. p).

MALAYA Malacca: Fish-ponds near Malacca.

Described from Indonesia.

67. **Achnanthes tropica** Hustedt. Valves linear elliptic, 12–15μ long × 2–3μ wide, with slightly convex to almost parallel sides, and rounded poles; epivalve with a lanceolate pseudoraphe and short marginal striae, 18–20 in 10μ, parallel to slightly radial; hypovalve with a linear-lanceolate axial area, narrower than the pseudoraphe, and a straight raphe, transverse striae slightly closer together 20–22 in 10μ, parallel. (Pl. IV, figs. m, n & o).

MALAYA Malacca: Fish-ponds near Malacca.

Described from Indonesia.

68. **Achnanthes woltereckii** Hustedt. Valves linear to linear-lanceolate, 10–15μ long × 3–4μ wide, with slightly convex margins and rostrate to capitate poles; epivalve with a lanceolate pseudoraphe, about 1/3 width of valve in the middle, transverse striae 20–24 in 10μ, slightly radial or parallel; hypovalve with a straight raphe and linear axial area, widening in the middle almost to reach the margin, transverse striae radial, 28–30 in 10μ, two or three opposite the central area so that it appears like a stauros. (Pl. IV, figs. i, j & k).

MALAYA Pahang: Cameron Highlands.

Described from Indonesia.

FRUSTULIA C. A. Agardh 1824; Grunow, 1865

Cells solitary and free-floating, or sessile and enclosed in a gelatinous sheath or sometimes a gelatinous tube; in valve view linear-elliptic to rhombo-lanceolate; in girdle view rectangular, without intercalary bands; central nodule longitudinally elongated, prolonged towards each pole as parallel ribs enclosing the raphe, and uniting apically with the polar nodule; transverse striations crossed by fine longitudinal lines; chromatophores two, sometimes incised longitudinally, one on each side of the girdle and connected by a cytoplasmic bridge.

Auxospores formed in pairs from two cells.

69. **Frustulia javanica** Hustedt. Valves elliptic-lanceolate, 50–60μ long × 25–26μ wide, with a distinct swelling on each side opposite the central nodule, and suddenly narrowed near the poles, making the margin triundulate; transverse striae fine, 24–27 in 10μ, parallel except at the poles and crossed by fine longitudinal striae 22 in 10μ. (Pl. VIII, fig. c).

MALAYA Pahang: Stream near Kuantan.

Reported from Indonesia and S. Africa.

The Pahang specimens are slightly broader and more lanceolate in shape than those described from Indonesia by Hustedt, but in all other respects they agree.

70. **Frustulia rhomboides** (Ehrenberg) de Toni. [Syn.: *Navicula rhomboides* Ehr.]. Valves rhombo-lanceolate, 50–80μ long × 12–15μ wide, hardly rostrate at the poles; transverse striae marked 27–28 in 10μ, longitudinal striae fine, 30 in 10μ. (Pl. VIII, figs. a & b).

MALAYA Penang.
Perak: Taiping.
Pahang: Cameron Highlands, Fraser's Hill, and in all of many streams sampled.
Selangor: Kuala Lumpur, Klang Gates, Klang.
Negri Sembilan: Port Dickson.
Malacca: Various localities.
Johore: Muar, Yong Peng, Kota Tinggi.
Singapore.

Worldwide and common in distribution.

71. **Frustulia saxonica** Rabenhorst. [Syn.: *Frustulia rhomboides* (Ehrenberg) de Toni v. *saxonica* (Rabh.) P. T. Cleve]. Valves elliptic, 30–40μ long × 8–10μ wide, slightly rostrate at the poles; transverse striae slightly radial, fine 35 in 10μ, longitudinal striae fine, 35 in 10μ. (Pl. VIII, figs. f & g).

MALAYA Pahang: Cameron Highlands.
Malacca: Fish-ponds, Malacca River.

Distribution worldwide.

GYROSIGMA Hassall 1845, emend. P. T. Cleve 1894

Cells solitary and free-floating, sometimes in gelatinous tubes; girdle view linear-lanceolate, intercalary bands and septa absent; valve view distinctly sigmoid, usually gradually attenuated to the broadly rounded poles, sometimes sharply narrowed; raphe sigmoid with small central and polar nodules; axial area narrow, with small, usually rounded, sometimes asymmetric, central area; transverse striae crossed by longitudinal striae at right angles; chromatophores two regularly or irregularly shaped plates, generally with several pyrenoids.

72. **Gyrosigma attenuatum** (Kuetzing) P. T. Cleve. [Syn.: *Pleurosigma attenuatum* W. Smith, *Navicula attenuata* Kuetz. var. *attenuata* Kuetz., *Pleurosigma attenuatum* W. Smith var. *caspia* Grun.]. Valves slightly sigmoid, 150–180μ long × 25–27μ wide, gradually attenuated to the rounded poles; raphe centrally placed, central area asymmetric, transverse striae slightly radial, 12–14 in 10μ, longitudinal striae wider apart, 10–12 in 10μ, (Pl. X, fig. c).

MALAYA Pahang: Stream near Kuantan.
Malacca: Malacca River.

Worldwide distribution.

The Malayan form is slightly wider than the type and might possibly be referred to var. *hippocampus* W. Smith.

73. **Gyrosigma distortum** (W. Smith) P. T. Cleve. [Syn.: *Pleurosigma distortum* W. Smith]. Valves sigmoid, 100μ long × 20–22μ wide, broad in the middle but sharply narrowed towards the poles; raphe centrally placed, central area elliptic; transverse striae marked, 15–16 in 10μ, longitudinal striae finer, 19–20 in 10μ. (Pl. X, fig. b).

MALAYA Pahang: Stream near Kuantan.

Widespread in distribution.

74. **Gyrosigma distortum** (W. Smith) P. T. Cleve var. **parkeri** (Harrison) P. T. Cleve. [Syn.: *Pleurosigma parkeri* Harrison]. Differs from the type in the much more sharply narrowed ends; valves distinctly sigmoid, 150–180μ long × 30–35μ wide, very sharply narrowed towards the poles; raphe central, central area elliptic; transverse striae marked, 15–17 in 10μ, longitudinal striae finer, 19–22 in 10μ. (Pl. IX, fig. e).

MALAYA Pahang: Stream near Kuantan.

Widespread in distribution.

75. **Gyrosigma excentricum** Prowse **sp. nov.** Valves linear sigmoid, 110–120μ long × 12–13μ wide, gradually narrowed towards the rounded poles; raphe very oblique, sigmoid, disappearing into the convex margins below the poles, central area elliptic, polar nodules very small, intra-marginal and almost invisible; longitudinal striae very fine, 20–22 in 10μ, transverse striae slightly wider apart, 18–20 in 10μ. (Pl. X, fig. d).

MALAYA Pahang: Stream near Kuantan. (Type locality).

Holotype No. Prowse 582c is deposited at the Tropical Fish Culture Research Institute, Malacca, Federation of Malaya.

Valvae lineari-sigmoidea, 110–120μ longae, 12–13μ latae, apicem versus utrinque gradatim attenuatae, summo rotundatae; raphe conformis, ex nodulo centrali ellipsoideo infra polum in marginem convexam utrinque evanescens; noduli polares minuti, in margine fere inconspicui; striae longitudinales gracillimae, 20–22 in 10μ, transversales distantiusculae 18–20 in 10μ.

MALAYA Pahang, in fluvio proximo urbe Kuantan.

This species is very distinct with its extremely oblique raphe. *G. rectum* (Donk.) P. T. Cleve, which has a similarly oblique raphe, is not sigmoid but is quite straight.

76. **Gyrosigma fasciolum** (Ehrenberg) P. T. Cleve var **arcuatum** (Donkin) P. T. Cleve. [Syn.: *Pleurosigma arcuatum* Donk., *Pleurosigma fasciola* W. Smith]. Valves markedly sigmoid, 90–100μ long × 13–15μ wide, very sharply narrowed towards the ends so that for a quarter of the length it is linear at each end and only 2–3μ wide; raphe central, central area almost circular; transverse striae 24–26 in 10μ, longitudinal striae about equally spaced. (Pl. X, fig. a).

MALAYA Pahang: Stream near Kuantan.

Described from N. Europe and usually regarded as marine, but many other Baltic forms have been found in fresh water.

77. **Gyrosigma scalproides** (Rabenhorst) P. T. Cleve var **eximium** (Thwaites) P. T. Cleve. [Syn.: *Schizonema eximium* Thwaites, *Colletonema eximium* Thwaites, *Endosigma eximium* Brébisson, *Pleurosigma eximium* van Heurck.]. Valves linear sigmoid, 50–55μ long × 10–12μ wide, margins parallel except near the poles where one margin is sharply bent to the rounded wedge-shaped pole, the other margin only very slightly concave; raphe central, curving at the poles towards the concave margin, central area elliptic; transverse striae 22–24 in 10μ, longitudinal striae 26–28 in 10μ. (Pl. IX, fig. 1).

MALAYA Pahang: Stream near Kuantan.

Cosmopolitan; reported from Indonesia.

78. **Gyrosigma spencerii** (W. Smith) P. T. Cleve var. **smithii** (Grunow) A. Cleve-Euler. [Syn.: *Pleurosigma spencerii* W. Smith var. *smithii* Grunow.]. Valves slightly sigmoid, 100–120μ long × 13–15μ wide, gradually narrowed to the rounded poles; raphe central, central area elliptic; transverse striae prominent, 18–22 in 10μ, longitudinal striae closer, 22–24 in 10μ. (Pl. IX, fig. f).

MALAYA Malacca: Malacca River.

Widespread in distribution.

PLEUROSIGMA W. Smith 1852, emend. P. T. Cleve 1894

Cells solitary, elliptic-lanceolate in girdle view, intercalary bands and septa usually absent; valves sigmoid, gradually tapering to rounded or sub-acute poles; raphe sigmoid, with small central and polar nodules; axial area narrow, central area usually round; striations consisting of transverse striae crossed obliquely in two opposite directions by other striae thus making 3 series of striations; chromatophores two, four, or many, regular or irregular plates.

Two auxospores formed from the conjugation of two cells.

79. **Pleurosigma elongatum** W. Smith. [Syn. *Pleurosigma angulatum* W. Smith var. *elongatum* W. Smith.]. Valves long, slightly sigmoid, uniformly narrowed to the rounded poles, 140–150μ long × 18–20μ wide; raphe central, central area small, rhombo-elliptic in shape; transverse striae 18–20 in 10μ, most clearly visible at the margins, oblique striae wider apart 16–19 in 10μ. (Pl. X, fig. f).

MALAYA Pahang: Stream near Kuantan.

Widespread, usually in brackish water.

80. **Pleurosigma salinarum** (Grunow) P. T. Cleve. [Syn.: *Pleurosigma delicatulum* W. Smith var. *salinarum* Grunow.]. Valves broad, slightly sigmoid, gradually narrowed to the rounded poles, 130–150μ long × 23–26μ wide; raphe central, central area small elliptic; transverse striae 20–22 in 10μ, oblique striae finer and closer together, 22–24 in 10μ. (Pl. X, fig. e).

MALAYA Pahang: Stream near Kuantan.

Widespread in brackish water. Reported from Indonesia.

CALONEIS P. T. Cleve 1891

Cells solitary, free-floating, linear or lanceolate, usually with convex sides and sometimes with marginal inflations in the valve view; girdle view rectangular; raphe straight with rounded central and polar nodules; transverse striations crossed by one or more longitudinal lines or hyaline areas parallel to the valve margin; intercalary bands absent; chromatophores usually two, irregular, each commonly with two pyrenoids.

81. **Caloneis ladogensis** P. T. Cleve var. **cuneata** A. Cleve. Valves linear elliptic, small 20–25μ long × 8–10μ wide, margins almost parallel in the middle, narrowing to almost cuneate poles; axial area narrow, central area abruptly widened to form a rectangle or stauros not reaching the margins; striae 16–19 in 10μ, punctate and crossed near each margin by two hyaline longitudinal lines parallel to the margin. (Pl. XVIII, fig. m).

MALAYA Pahang: Cameron Highlands.

Reported from N. Europe.

This form can only come here, corresponding in all ways—shape, rectangular central area and density of striations.

82. **Caloneis silicula** (Ehrenberg) P. T. Cleve var. **minuta** P. T. Cleve. [Syn.: *Navicula ventricosa* Ehr. forma *minuta* Grunow, *Caloneis silicula* (Ehr.) P. T. Cleve var. *gibba* Mayer.]. Valves small, 28–30μ long × 7–8μ wide, linear lanceolate with triundulate margins and wedgeshaped poles; axial area narrow, central area a wide stauros reaching the margins; striae parallel, 19–21 in 10μ, finely punctate and crossed by a hardly visible longitudinal line close to each margin. (Pl. XIV, fig. n).

MALAYA Malacca: Fish-ponds.

Described from freshwater of Europe, not common.

NEIDIUM Pfitzer 1871

Cells usually solitary and free-floating; girdle view rectangular without intercalary bands; valve view linear, lanceolate, elliptic or irregularly undulate with poles acute, rounded, nearly capitate or rostrate, axial field usually narrow, with rounded or elliptic central area; raphe straight, usually bifurcated at the poles, with central ends facing in opposite directions; transverse striae punctate, crossed near the margin by narrow longitudinal hyaline spaces or lines; chromatophores two, longitudinally incised and thus often appearing as four, each with a pyrenoid.

Auxospores two, formed by the conjugation of two approximated cells.

83. **Neidium hitchcockii** (Ehrenberg) P. T. Cleve. [Syn.: *Navicula hitchcockii* Ehr.]. Valves linear, 65–70μ long × 16–18μ wide, with three prominent undulations on each margin, narrowing to the cuneate, sub-acute poles; axial area narrow, widening at

the poles, central area obliquely ellipsoid; striae punctate, oblique, 18–20 in 10μ, crossed near each margin by a longitudinal hyaline line. (Pl. IX, fig. a).

MALAYA Malacca: Fish-ponds in Malacca and Jasin.

Widespread in distribution.

Hustedt (1938) has described *N. gracile* from Indonesia, and for geographical reasons the Malayan forms should be included under that name. However Hustedt's reasons for separating off the species on the grounds of a narrow axial area and it being tropical, are so unconvincing that I would prefer to keep the species as *N. hitchcockii.* Ehrenberg's original description makes no reference to the width of the axial area, and other descriptions of *N. hitchcockii* from north temperate areas (A. Cleve-Euler 1955, Tiffany & Britton 1952) refer to a narrow axial area; so there seems to be no difference between the forms found in temperate waters and those found in the tropics.

84. **Neidium iridis** (Ehrenberg) P. T. Cleve var. **ampliatum** (Ehrenberg) P. T. Cleve. [Syn.: *Navicula iridis* Ehr., *Navicula ampliata* Ehr., *Navicula affinis* Greg., *Neidium iridis* (Ehr.) P. T. Cleve var. *intercedens* Mayer.]. Valves elliptic lanceolate, 35–90μ long × 10–20μ wide, subrostrate at the poles, thus differing from the type species; axial area narrow, widening at the poles, central area obliquely elliptic; striae punctate, parallel to oblique, 16–18 in 10μ, crossed near each margin by a longitudinal hyaline line. (Pl. IX, figs. c & d).

MALAYA Malacca: Malacca River, fish-ponds in Malacca town area.

Widespread in distribution.

85. **Neidium productum** (W. Smith) P. T. Cleve [Syn.: *Navicula producta* W. Smith, *Neidium productum* Hustedt, *Neidium capitatum* A. Cleve, *Neidium capitatum* A. Cleve var. *prolongata* A. Cleve.]. Valves linear-elliptic, with only slightly convex sides, 75–80μ long × 18–20μ wide; distinctly rostrate with rounded poles; axial area narrow, wider at the poles, central area round; striae punctate, parallel, 15–18 in 10μ, crossed near each margin by a prominent, longitudinal, hyaline line. (Pl. IX, fig. b).

MALAYA Malacca: Malacca River, fish-pond near Jasin.

Probably more widespread in Malaya.

Distribution worldwide.

86. **Neidium productum** (W. Smith) P. T. Cleve var. **minor** A. Cleve. Smaller than the type, 40–45μ long × 8–10μ wide, with practically straight valve margins and markedly rostrate to subcapitate poles; striae 19–20 in 10μ, crossed near each margin by a longitudinal, hyaline line. (Pl. XII, fig. p).

MALAYA Pahang: Cameron Highlands.

Widespread in distribution.

DIPLONEIS Ehrenberg 1844

Cells solitary, rectangular in girdle view, valves usually elliptic, sometimes linear, or with a median constriction; central nodule quadrate, prolonged towards each pole as a pair of parallel horns or ribs enclosing the raphe and with a longitudinal furrow on each side of the horns and central nodule; transverse striations costate or with coarse punctae or alveolae, often crossed by longitudinal costae or rows of punctae; chromatophores two, sometimes longitudinally incised.

87. **Diploneis bombus** Ehrenberg var. **minor** P. T. Cleve. [Syn.: *Navicula gemina* Ehrenberg.]. Valves linear elliptic, 40–46μ long × 9–10μ wide, markedly constricted in the middle to give the shape of a broad figure eight, narrowing gradually at the poles to a rounded wedge shape; central nodule large and the paired ribs or horns straight or only slightly curved; transverse costae radial, 7–9 in 10μ, each with coarse alveoli, a row of punctate on each side of the central furrows; costae crossed by longitudinal costae, 4 in the widest part and 2 at the poles. (Pl. XIII, fig. g).

Malaya Pahang: Stream near Kuantan.

Described from N. Europe in brackish and marine waters, but in Malaya found in non-saline water, although near the coast.

88. **Diploneis decipiens** A. Cleve var. **parallela** A. Cleve. [Syn.: *Diploneis elliptica* (Kuetz.) P. T. Cleve var. *linearis* A. Cleve.]. Valves linear-elliptic, small, 18–20μ long × 10μ wide, ribs or horns narrow, straight, not widened at the central nodule, longitudinal furrows straight; transverse costae nearly parallel in the middle, radial near the poles, 12 in 10μ, each with a row of coalescing punctae, a single row of punctae on either side of the central furrows. (Pl. IX, fig. i).

Malaya Pahang: Stream near Kuantan.

Described from brackish water in N. Europe.

89. **Diploneis interrupta** (Kuetzing) P. T. Cleve. [Syn.: *Navicula interrupta* Kuetzing.]. Cells elliptic, constricted in the middle, small, 27–30μ long × 10–12μ wide; ribs or horns almost straight, central furrows straight; transverse costae radial, absent opposite the central nodule, 10–12 in 10μ, each with 4 large coarse punctae or alveolae in the widest part of the valve, 2 at the poles, and a row of smaller punctae each side of the central furrows. (Pl. IX, fig. k).

Malaya Pahang: Stream near Kuantan.

Described from brackish water in N. Europe.

90. **Diploneis oblongella** (Naegeli) P. T. Cleve var. **baltica** A. Cleve. [Syn.: *Navicula oblongella* Naeg., *Diploneis ovalis* (Hilse) P. T. Cleve var. *oblongella* Fontell, *Diploneis oblongella* (Naegeli) Cleve var. *fossilis* (Pantoscek) A. Cleve, *Navicula ovalis* var. *fossilis* Pantoscek.]. Valves linear—elliptic, 30–40μ long × 15–17μ wide, margins only slightly convex, nearly parallel, poles smoothly rounded; ribs or horns narrow, straight, furrows narrow, slightly widened in the middle; costae prominent, almost parallel in the middle, radial at the poles, 12–13 in 10μ, punctate with 12–14 punctae in 10μ short costae of 2–3 punctae either side of the furrows. (Pl. IX, fig. j).

MALAYA Pahang: Stream near Kuantan.

Widespread in freshwaters.

91. **Diploneis ovalis** (Hilse) P. T. Cleve. [Syn.: *Navicula ovalis* Hilse.]. Valves broadly elliptic, 20–25μ long × 12–15μ wide, tapering gradually to the rounded poles; central nodule large, ribs or horns narrow, furrows narrow, widening markedly opposite the central nodule; costae radial, 12–16 in 10μ, punctate, with 16–20 punctae in 10μ, a row of costae with 1–4 punctae on each side of the central furrows. (Pl. IX, fig. h).

MALAYA Pahang: Cameron Highlands, and a stream near Kuantan.

Selangor: Gombak River.

Malacca: Malacca River.

Doubtless to be found elsewhere in Malaya.

Distribution worldwide in freshwaters.

92. **Diploneis parma** P. T. Cleve. Valves elliptic, 23–26μ long × 14–15μ wide, tapering gradually to the rounded poles; central ribs narrow, slightly wider near the central nodule, central nodule small; furrows expanded in the centre to enclose a lanceolate central area about 1/3 the width of the valve; costae radial, 11–13 in 10μ, each with two alternating rows of fine punctae, a row of short prominent costae on each side of the central furrows. (Pl. XIII, fig. 1).

MALAYA Pahang: Stream near Kuantan.

Distribution in European freshwaters.

This species closely resembles *D. smithii* (Bréb.) P. T. Cleve, but is much smaller, with a smaller central nodule and finer punctae.

STAURONEIS Ehrenberg 1843

Cells solitary or united valve to valve in short filaments; girdle view rectangular, sometimes with intercalary bands; valve view elliptic, lanceolate or rhombic, often capitate, sometimes with longitudinal septa visible at the poles; raphe usually straight, axial area usually narrow, occasionally wider, always widened suddenly in the middle to form a stauros reaching the margins; striae parallel or slightly radial, finely punctate; chromatophores two with two to four pyrenoids.

Auxospores formed in pairs between two conjugating cells.

93. **Stauroneis acuta** W. Smith. Cells joined at the valves to form short filaments; valves rhombo-lanceolate, 65–75μ long × 18–20μ wide, somewhat inflated in the middle and tapering to rounded poles; raphe straight, axial area moderately wide, in the middle expanded to the margins to form a stauros, central area of stauros rhombic in shape, lateral limbs wider at the margin; poles with visible septa; striae radiate, 14–18 in 10μ, punctate. (Pl. XIII, fig. f).

MALAYA Malacca: Malacca River.

Widespread in freshwater, although not common.

This is a very characteristic species, especially in shape. The Malayan specimens have a slightly finer structure than the type, but hardly sufficiently so to warrant erecting a new variety.

94. **Stauroneis anceps** Ehrenberg. Valves lanceolate, 90–110μ long × 18–20μ wide, with distinctly capitate poles; raphe straight, narrow, axial area narrow, widened in the middle to form a stauros reaching the margins; striae radial, 16–18 in 10μ, punctate. (Pl. XIII, fig. d).

MALAYA Malacca: Malacca River.

Widespread in freshwater.

95. **Stauroneis anceps** Ehrenberg var. **gothica** A. Cleve-Euler. Valves elliptic-lanceolate, 28–30μ long × 8–9μ wide, with markedly rostrate to sub-capitate poles; axial area narrow, stauros wide, wider at the margins, each limb with 5 short marginal striae; striae radial, 18–20 in 10μ, finely punctate. (Pl. XIII, fig. j).

MALAYA Pahang: Cameron Highlands.

Described from N. European freshwaters.

96. **Stauroneis anceps** Ehrenberg var. **hyalina** A. Brun and Peragallo. Valves lanceolate, 45–50μ long × 8–9μ wide, with poles hardly rostrate but almost acute; axial area very narrow, limbs of stauros very narrow, only 2 or 3 striae wide; striae fine, hardly visible, 25–30 in 10μ. (Pl. XIII, fig. k).

MALAYA Pahang: Stream near Kuantan.

Widespread in freshwaters.

97. **Stauroneis obtusa** Lagerstedt. Valves linear lanceolate, 40–50μ long × 8–10μ wide, narrowing gradually to the broadly rounded almost truncate poles, with visible septa at the poles; axial area narrow, in the middle widening to a prominent stauros the limbs of which are wider at the margins; striae punctate, radial, 19–20 in 10μ. (Pl. XIII, fig. i).

MALAYA Pahang: Stream near Kuantan.

Widespread in freshwaters but not common.

98. **Stauroneis phoenicenteron** (Nitzsch) Ehrenberg var. **elegans** Prowse **var. nov.** Valves linear-lanceolate, 90μ long × 12μ wide, slightly constricted in the middle, narrowed very slightly below the rounded apices; axial area narrow, expanded in the middle to form a stauros opposite each limb of which are 4–5 short, marginal striae, striae punctate, distinctly radial 18–25 in 10μ. (Pl. XII, fig. d).

MALAYA Malacca: Fish-ponds.

Holotype Prowse No. 504a is deposited at the Tropical Fish Culture Research Institute, Malacca, Federation of Malaya.

Valvae lineari-lanceolate, 90μ longae, 12μ latae, medio leviter constrictae, infra apices rotundatos paululo angustatae. Striae punctatae, manifeste radiales, 18–25 in 10μ. Area centralis circum raphen sita, angusta, medio in staurum dilatata, 4–5 striis brevibus marginalibus adversus eum ornata.

MALAYA Malacca, in stagnis piscosis.

99. **Stauroneis phoenicenteron** (Nitzsch) Ehrenberg var. **halmei** Moelder forma **marginestriata** A. Cleve-Euler. Valves broadly lanceolate, 29–30μ long × 9–10μ wide, with broad, very slightly rostrate poles; axial area narrow, widening in the middle to a stauros with 3 short marginal striae opposite each limb of the stauros; striae lightly radial, punctate, 17–20 in 10μ. (Pl. XIII, fig. c).

MALAYA Pahang: Cameron Highlands.

Described from freshwaters in N. Europe.

The Malayan specimens are much smaller than the type. They are however obviously a form of *S. phoenicenteron* and apart from size agree closely with var. *halmei* f. *marginestriata*.

100. **Stauroneis phoenicenteron** (Nitzsch) Ehrenberg var. **intermedia** (Dippel) A. Cleve-Euler. [Syn.: *S. phoenicenteron* var. *vulgaris* Dippel forma *intermedia* Dippel, *S. phoenicenteron* var. *brevis* A. Cleve.]. Valves broadly lanceolate, 70–120μ long × 15–25μ wide, with rounded lightly rostrate poles; axial area

linear, moderately wide, widening in the middle to form a stauros reaching the lateral margins; striae radial, punctate, 13–16 in 10μ. (Pl. XIII, figs. e & h).

MALAYA Selangor: Gombak River.

Malacca: Fish-ponds.

Probably widespread in Malaya.

Cosmopolitan in distribution.

101. **Stauroneis pusilla** A. Cleve var. **franconica** (Mayer) A. Cleve-Euler. [Syn.: *S. anceps* Ehrenberg var. *pusilla* A. Cleve, *S. franconica* Mayer.]. Valves lanceolate, 30–45μ long × 7–11μ wide, capitate at the poles, axial field narrow, widening in the middle to form a stauros reaching the margins; striae difficult to see, visible only with phase contrast under oil immersion, more than 30 in 10μ. (Pl. XIII, figs. a & b).

MALAYA Pahang: Cameron Highlands.

Reported from European freshwaters.

The Malayan specimens are slightly larger than the type, but the extremely fine striae, and the shape, make it reasonable to include them under the above variety.

ANOMOEONEIS Pfitzer 1871

Cells generally solitary, rectangular in girdle view, in valve view lanceolate to rhombic and elliptic, regularly with convex sides and sometimes with a median inflation, poles acute, rounded or capitate; axial area usually narrow, with a circular or rhombic central area, but sometimes widening into a large lyrate area; raphe straight; transverse striations crossed by longitudinal, zig-zag, hyaline lines; intercalary bands absent; chromatophore single, laminate, longitudinally incised. Two auxospores formed from the union of gametes in pairs from two sister cells enclosed in a gelatinous envelope.

102. **Anomoeoneis brachysira** (Brébisson) Grunow. [Syn.: *Navicula brachysira* Brébisson.]. Valves broadly rhombo-lanceolate, 20–25μ long × 7–8μ wide, poles broadly rounded; axial area narrow, central area round-rhombic; transverse striae 25–27 in 10μ crossed by two zig-zag hyaline longitudinal lines on each side of the raphe. (Pl. XI, fig. j).

MALAYA Pahang: Cameron Highlands.

Widespread in freshwaters.

103. **Anomoeoneis serians** (Brébisson) P. T. Cleve var. **acuta** Hustedt. [Syn.: *Frustulia serians* Bréb., *Navicula serians* (Bréb.) Kuetz.]. Valves rhombo-lanceolate, 40–50μ long × 8–9μ wide, uniformly narrowed to the acute poles; axial area narrow, central area round-rhombic; transverse striae 24–27 in 10μ, crossed by 2–3 zigzag, hyaline longitudinal lines. (Pl. XI, figs. b & c).

MALAYA Malacca: Fish-ponds and swamps.

Described from Indonesia.

NAVICULA Bory 1822, emend. P. T. Cleve 1894

Cells generally solitary and free-floating, sometimes aggregated into irregularly radiating clusters, occasionally joined valve to valve to form ribbons; girdle view rectangular, with smooth girdles and without intercalary bands; valve view elongate, lanceolate to elliptic, sometimes with undulate margins, frequently attenuated to capitate, rostrate or rounded poles; axial field usually narrow, central area variable, occasionally expanded and fusing to form large, lyrate, hyaline areas; raphe straight, simple, with polar and central expansions; transverse striations medianly radial to parallel, sometimes with regular or irregular cross lines, in some species pseudocostate through the coalescence of coarse punctae, but the costae without internal openings. Chromatophores laminate, two, rarely four to eight, occasionally with one or more pyrenoids.

Auxospores formed in pairs by the fusion of two gametes from each of two approximated cells.

A very large and variable genus, probably the largest amongst the freshwater diatoms and often divided into subgenera.

104. **Navicula amphibola** P. T. Cleve. Valves elliptic-lanceolate, 28–30μ long × 12–13μ wide, narrowing suddenly to rostrate poles; axial area narrow, central area rectangular, almost stauroid; striae radial, punctate, 13–16 in 10μ, shorter in the middle. (Pl. XI, figs. k & l; Pl. XII, fig. h).

MALAYA Malacca: Malacca River.

Widespread in freshwaters.

The Malayan form is distinctly smaller and more finely punctate than the type and perhaps it ought to be separated off as a variety. However the shape, proportions and density of the striae correspond closely to those of the species.

105. **Navicula anglica** Ralfs. [Syn.: *Navicula tumida* W. Smith var. *genuina* Grunow, *Navicula gastrum* Ehrenberg var. *anglica* Grunow.]. Valves elliptic-lanceolate, 25–28μ long × 7–9μ wide,

poles rostrate; axial area narrow, central area small, round; striae radial well marked, 10–14 in 10μ, shorter in the middle. (Pl. XI, fig. u).

MALAYA Selangor: Stream near Klang Gates Reservoir.

Widespread in freshwaters.

106. **Navicula antiqua** A. Cleve. [Syn.: *Navicula dicephala* (Ehr.) W. Smith var. *subcapitata* Mayer, *Navicula pinnularioides* Oestrup var. *continua* A. Cleve.]. Valves linear, 18–22μ long × 7–8μ wide, with parallel or slightly concave sides and decidedly wedge-shaped poles; axial area narrow, central area round; striae slightly radial, 8–12 in 10μ. (Pl. XI, fig. s).

MALAYA Pahang: Cameron Highlands.

Found in N. European freshwaters.

The Malayan specimens fit best into this species, although no forms with concave sides have been reported from Europe.

107. **Navicula arenaria** Donkin. [Syn.: *Navicula lanceolata* Kuetz. var. *arenaria* (Donk.) P. T. Cleve.]. Cells in girdle view with distinctly convex sides, slightly constricted in the middle opposite the central nodules; in valve view lanceolate with acute poles, 45–50μ long × 9–10μ wide, often lying slightly tilted laterally due to the convexity of the valve and the poles then appearing to curve slightly to one side; raphe straight, following the central line of the valve and curving in to the central nodule, appearing to curve slightly to one side when the valve is tilted laterally; axial area narrow, central area small; striae prominent, coarsely punctate, radial, 8–9 in 10μ, broken by a short, hyaline longitudinal line on one side of the central area. (Pl. XII, fig. a).

MALAYA Pahang: Stream near Kuantan.

Usually regarded as marine, but here described from non-saline water where it was in company with many healthy large desmids. In some respects the Malayan forms resemble *Navicula lanceolata* (Ag.) Kuetzing, but the valves in that species are straight in girdle view, not convex as in the present forms. Thus the Malayan forms more closely agree with *Navicula arenaria* Donk. from which they differ only by the break in the striae on one side of the central area. Whether this difference is sufficiently consistent for varietal status remains to be seen.

108. **Navicula brasiliensis** Grunow var. **minor** Prowse **var. nov.** Valves elliptic lanceolate, 35–40μ long × 17–18μ wide, slightly rostrate at the poles; axial field narrow, central area small, round; striae slightly radial, 9–12 in 10μ, punctate; the punctate closer together at the margins forming short transverse

marginal lines, inner punctae wider apart on wavy longitudinal lines. Differs from the type in being much smaller and with more rostrate poles. (Pl. XII, fig. g).

MALAYA Pahang: Stream near Kuantan. (Type locality).

Holotype Prowse No. 582d is deposited at the Tropical Fish Culture Research Institute, Malacca, Federation of Malaya.

This species is usually regarded as marine but is here found in non-saline water.

A forma typica haec varietas differt natura minore et plure rostratorum apicorum.

Valvae ellipticae-lanceolatae, apicibus rostratiusculis, 35–40μ longae, 17–18 latae; area axialis angusta, area centralis minuta rotunda; striae radialiusculae, 9–12 in 10μ, punctatae, puncta in marginem propinquitatioria versus marginem lineis brevibus transversalibus formatis, et puncta versus partem mediam distantiuscula lineis longitudinalibus sinuosis formatis.

MALAYA Pahang: in fluvio proximo urbe Kuantan.

109. **Navicula cancellata** Donkin var. **apiculata** Grunow. Cells in girdle view with curved edges, concave at poles, slightly concave in the middle, valve view linear, 40–50μ long × 8–10μ wide, with acute wedge-shaped poles appearing one sided when valve is slightly tilted laterally; axial area narrow, suddenly widened at the central nodule where there is one short marginal stria on each side; striae very prominent, 8–10μ, parallel and formed by coalescing coarse punctae longitudinally streaked. (Pl. XI, fig. w).

MALAYA Pahang: Stream near Kuantan.

Usually regarded as marine, but here found in non-saline water.

110. **Navicula confervacea** Kuetzing. Cells united valve face to valve face to form short ribbons; valves lanceolate, 18–25μ long × 7–9μ wide; axial area lanceolate, slightly widened at the central area; transverse striae fine, radial, 18–20 in 10μ. (Pl. XII, figs. n & o).

MALAYA Malacca: Fish-ponds, attached to the roots of *Eichornia*.

Widespread, especially in the tropics.

This is most easily recognised by its ribbon like habit.

111. **Navicula crucifera** Grunow. [Syn.: *Navicula apiculata* Brébisson, *Navicula apiculata* Brébisson var. *maculifera* Grunow.]. Cells in girdle view with convex margins, sometimes slightly concave in the middle; valves linear-lanceolate, 45–50μ

long × 14–16μ wide, tapering to acute poles; axial area narrow, central area wide, rectangular; striae somewhat radial 6–8 in 10μ very prominent, longitudinally streaked through the coalescence of coarse punctae, striae opposite central area much shorter and sometimes unequal in length. (Pl. XI, fig. p).

MALAYA Pahang: Stream near Kuantan.

Generally regarded as marine but here found in freshwater in the company of large desmids.

112. **Navicula cryptocephala** Kuetzing var. **veneta** (Kuetzing) Grunow. [Syn.: *Navicula veneta* Kuetzing, *Navicula lancettula* Schumann, *Navicula cryptocephala* Kuetz. var. *lancettula* van Heurck, *Navicula cryptocephala* Kuetz. var. *pumila* (Grun.) P. T. Cleve.]. Valves linear-lanceolate to rhombo-lanceolate, 23–25μ long × 5–7μ wide, evenly tapered to the roundish poles; axial area narrow, central area very small; only slightly widened; striae somewhat radial, fine, 15–16 in 10μ. (Pl. XI, fig. r).

MALAYA Pahang: Cameron Highlands.

Widespread in distribution, often in brackish water, but here in decidedly non-saline water far from the sea.

113. **Navicula cuspidata** Kuetzing var. **ambigua** (Ehrenberg) P.T. Cleve. [Syn.: *Navicula ambigua* Ehr.]. Valves lanceolate, 95–100μ long × 25–30μ wide, tapering to markedly rostrate to sub-capitate poles; axial area narrow, central area hardly wider, but elongated; transverse striae parallel, 17–18 in 10μ, distinctly punctate and crossed by longitudinal striae, 22–25 in 10μ. (Pl. XII, fig. e).

MALAYA Malacca: Malacca River.

Widespread but not common.

114. **Navicula disparata** Hustedt. Valves elliptic-lanceolate, 20–25μ long × 8–10μ wide, tapering to slightly rostrate poles; axial area lanceolate, widening in the middle to a roundish central area about 1/3 width of the valve; striae radial, fine, 20–22 in 10μ at the poles, wider spaced in the middle. (Pl. XII, fig. m).
MALAYA Pahang: Stream near Kuantan.

Described from Indonesia.

The Malayan specimens are slightly larger than Hustedt's, but in all other respects agree.

115. **Navicula elegantoides** Hustedt. Valves elliptic-lanceolate, 75–80μ long × 30–35μ wide, tapering to the distinctly rostrate poles; axial area widish, very much widened in the middle to

form a circular central area; striae slightly radial in the middle, convergent at the poles, 5 in 10μ, thick but apparently smooth. (Pl. VIII, fig. d).

MALAYA Malacca: Malacca River.

Described from the Philippines.

The species looks almost costate, but cannot be classed as a *Pinnularia* because the pseudocostae have no internal openings.

116. **Navicula feuerborni** Hustedt. Valves narrow-lanceolate, 40–48μ long × 6–8μ wide, evenly tapered to the rounded poles; axial area moderately narrow, asymmetrical, central area a long ellipse not clearly set off and distinctly asymmetrical in shape; raphe straight except at the poles where it is clearly hooked; striae fine but distinct, radial in the middle, convergent at the poles; 10–12 in 10μ in the middle, slightly closer together at the poles; sometimes of uneven length opposite one side of the central area. (Pl. XI, fig. f).

MALAYA Pahang: Cameron Highlands.

Described from Indonesia.

117. **Navicula gastrum** Ehrenberg. Valves broadly elliptic lanceolate, 25–30μ long × 11–15μ wide, with short broadly rostrate poles; axial area narrow, central area irregularly roundish to rectangular, raphe straight; striae radial, 8–12 in 10μ, of irregular lengths opposite the central area. (Pl. XI, fig. v).

MALAYA Malacca: Malacca River.

Cosmopolitan in freshwater.

118. **Navicula glacialis** P. T. Cleve var. **septentrionalis** P. T. Cleve. Valve broadly elliptic-lanceolate, 45–50μ long × 25–30μ wide; axial area narrow, central area rectangular; striae 9–10 in 10μ, punctate with the punctae close together forming short marginal transverse lines, and the inner punctae much wider apart forming wavy longitudinal lines. (Pl. XI, fig. h).

MALAYA Pahang: Stream near Kuantan.

Generally described as marine, but here definitely in freshwater.

119. **Navicula grevillei** (C. A. Agardh) P. T. Cleve. [Syn.: *Schizonema grevillei* C. A. Agardh, *Schizonema comoides* van Heurck, *Navicula rhombica* Donkin). Cells in girdle view with curved margins, convex at the poles, slightly concave in the middle; valve-view lanceolate to rhombo-lanceolate, 45–55μ long × 12–15μ wide, tapered to the rounded poles; axial area narrow, central area small, elliptic; striae fine, punctate, slightly radial, 18–20 in 10μ, much wider apart opposite the central area. (Pl. XII, fig. b).

MALAYA Pahang: Stream near Kuantan.

Generally regarded as marine, but here found in freshwater.

120. **Navicula halophila** (Grunow) P. T. Cleve var. **subcapitata** Oestrup. Valves lanceolate, 30–35μ long × 8–9μ wide, tapering to sub-capitate poles, axial area narrow, central area hardly wider; transverse striae parallel, finely punctate, 19–20 in 10μ. (Pl. XI, fig. t).

MALAYA Malacca: Malacca River.

Widespread in distribution, mainly in brackish water.

121. **Navicula hungarica** Grunow var. **luneburgensis** Grunow. Valves lanceolate, 19–20μ long × 5–6μ wide, tapering to almost acute poles; axial area narrow, central area slightly widened; striae very prominent, 10 in 10μ, radial and longitudinally striated through the coalescence of the coarse punctae. (Pl. XI, fig. c1).

MALAYA Pahang: Stream near Kuantan.

Widespread in distribution.

122. **Navicula hustedtii** Krasske. Valve elliptic-lanceolate, 15–20μ long × 5–6μ wide, constricted beneath the distinctly capitate poles; axial area narrow, central area small, round; striae radial, 26–30 in 10μ, slightly wider apart opposite the central area. (Pl. XII, fig. k).

MALAYA Malacca: Fish-ponds.

Widespread in distribution.

123. **Navicula lagerheimi** P. T. Cleve var. **intermedia** Hustedt. Valves rhombic, 24–28μ long × 8–9μ wide, evenly tapered to the broadly rounded poles; axial area narrow, central area rectangular, stauroid; striae radial, 20–22 in 10μ distinctly punctate, very short opposite the central area and with a single prominent pore on one side of the central area. (Pl. XI, fig. n).

MALAYA Malacca: Malacca River.

Described from Indonesia.

Perhaps this species and its varieties ought to be merged with *Navicula mutica* Kuetzing, from which they show little difference.

124. **Navicula lyra** Ehrenberg var. **dilatata** A. Schmidt. Valves elliptic, 50–60μ long × 30–35μ wide, very slightly rostrate at the rounded poles; axial area linear, widening at the centre to join the lateral longitudinal hyaline spaces, the lateral hyaline areas diverging from the middle and then slightly converging again near the poles, thus forming a lyrate area; striae punctate, slightly radial, 11 in 10μ. (Pl. XII, fig. c).

MALAYA Pahang: Stream near Kuantan.

Generally regarded as marine, but here found in non-saline water. A very characteristic form.

125. **Navicula lyra** Ehrenberg var. **ehrenbergii** P. T. Cleve. [Syn.: *Navicula lyra typica* van Heurck.] Valves elliptic, 55–60μ long × 23–25μ wide, markedly rostrate at the poles and slightly constricted in the middle of the sides; axial area linear, fusing in the centre with the lateral longitudinal hyaline areas, lateral areas diverging only very slightly in the middle and converging slightly at the poles, forming a lyrate shape; striae punctate, slightly radial, 12–14 in 10μ. (Pl. XI, fig. o).

MALAYA Pahang: Stream near Kuantan.

Usually regarded as marine.

126. **Navicula microcephala** Grunow. Valves narrow-lanceolate, 18–30μ long × 3μ wide, with sub-capitate poles; axial area narrow, linear to linear lanceolate; transverse striae fine, 30 or more in 10μ, strictly parallel. (Pl. XII, fig. q).

MALAYA Malacca: Fish-ponds.

Widespread in freshwaters, but not common.

127. **Navicula minima** Grunow. Valves linear-elliptic, 14–16μ long × 4–5.5μ wide, with broad rounded poles; axial area narrow, central area rectangular; transverse striae somewhat radial, 26 in 10μ, shorter and wider spaced opposite the central area. (Pl. XI, fig. z).

MALAYA Malacca: Malacca River.

Widespread in freshwaters.

128. **Navicula minuscula** Grunow. Valves lanceolate, 12–15μ long × 4–5μ wide, narrowing gradually to the slightly rostrate, rounded poles; axial area very narrow, central area no wider or even slightly constricted; striae hardly radial, fine, more than 30 in 10μ. (Pl. XI, fig. y).

MALAYA Malacca: Malacca River.

Widespread in freshwaters.

129. **Navicula ostenfeldii** Oestrup. Valves small, lanceolate, 25–28μ long × 6–7μ wide, with capitate poles; axial area narrow, central area only slightly wider; striae fine, strictly parallel, 25–30 in 10μ. (Pl. XII, fig. 1).

MALAYA Malacca: Malacca River.

Freshwater, widespread.

The Malayan forms are slightly larger than the type.

130. **Navicula placenta** Ehrenberg var. **obtusa** Meister. Valves broadly elliptic-lanceolate, 50–55μ long × 25–30μ wide, gradually narrowing to the broadly rounded poles; axial area narrow, central area small, round; striae punctate forming three

series consisting of transverse lines crossed by two sets of oblique striae and punctae widest apart in the middle and much closer together near the margins and the poles. (Pl. XI, fig. g).

MALAYA Malacca: Malacca River.

So far only described from Asia, including Indonesia.

An unmistakable form.

131. **Navicula platystoma** Ehrenberg. [Syn.: *Stauroneis platystoma* Ehrenberg.]. Valves broadly lanceolate, 20–25μ long × 10–14μ wide, distinctly rostrate at the poles; axial area narrow, central area lanceolate, laterally elongated; striae radial, 15–19 in 10μ, shorter opposite the central area. (Pl. XI, fig. i).

MALAYA Selangor: Mountain streams near Klang Gates Reservoir.

This form closely resembles var. *minor* Schulz, from which it differs only in being much smaller. Whether it should be classed as a separate variety is a moot point.

132. **Navicula punctulata** F. Smith. Valves elliptic, 24–27μ long × 14–15μ wide, with broadly rounded poles; axial area narrow, central area circular; striae radial, 12–14 in 10μ, punctate with the punctae equidistant on the striae. (Pl. XI, fig. d1).

MALAYA Pahang: Stream near Kuantan.

Most forms described from marine or brackish water habitats. The present form is small and was found in non-saline water. Possibly it should be separated as a variety.

133. **Navicula pupula** Kuetzing var. **capitata** Hustedt. Valves linear or almost so, 40–45μ long × 10μ wide, with slightly convex margins and slightly sub-capitate poles; axial area narrow, but widening at the poles; central area somewhat rectangular, but lateral "wings" wider near the margins; striae radial, 13–15 in 10μ in the middle, 22–24 in 10μ near the poles, short opposite the central area, and distinctly curving outwards near the pole leaving a wide polar area. (Pl. XI, fig. a).

MALAYA Malacca: Fish-ponds.

Widespread in distribution.

The present form is somewhat intermediate between var. *capitata* Hustedt and var. *rectangularis* (Greg.) Grunow, but comes closer to the former.

134. **Navicula pusilla** W. Smith. Valves elliptic-lanceolate, 35–40μ long × 18–20μ wide, distinctly rostrate, almost citriform in appearance; axial area narrow, central area moderately large,

elliptic; striae punctate, radial 12–18 in 10μ, widest apart in the middle with mixed long and short striae opposite the central area, punctae closer together, 18–22 in 10μ. (Pl. XII, fig. f).

MALAYA Pahang: Stream near Kuantan.

Widespread in brackish water but also reported from freshwater. The present form must come here, even though the central area is of different shape.

135. **Navicula radiosa** Kuetzing var. **minutissima** (Grunow) P. T. Cleve. [Syn.: *Navicula tenella* Brébisson var. *minutissima* Grunow.]. Valves narrow-lanceolate, 27–30μ long × 5–6μ wide, with rounded poles; axial area narrow, central area round; striae radial in the middle, convergent at the poles, 18–19 in 10μ. (Pl. XI, fig. m).

MALAYA Perak: Taiping lakes.

Widespread in freshwaters.

136. **Navicula rhyncocephala** Kuetzing. Valves lanceolate, 28–30μ long × 6–8μ wide, with slightly elongated, capitate poles; axial area narrow, central area elliptic to circular; striae well-marked, radial in the middle, somewhat convergent at the poles, 12–14 in 10μ, closer together at the poles. (Pl. XI, figs. d & q).

MALAYA Pahang: Cameron Highlands.

Widespread in freshwaters.

The Malayan form is a small form, but differs only in size.

137. **Navicula rotaeana** (Rabenhorst) Grunow. [Syn.: *Stauroneis rotaeana* Rabenhorst, *Stauroneis ovalis* Gregory.]. Valves small, broadly elliptic, 14–16μ long × 8–9μ wide, with broadly rounded poles; axial area moderately wide, central area stauroid, not reaching the margins; striae fine, somewhat radial, 25–28 in 10μ, shorter and slightly wider apart opposite the central area. (Pl. XI, fig. x).

MALAYA Selangor: Mountain stream near Klang Gates reservoir.

Widespread in distribution.

138. **Navicula schroeteri** Meister. Valves linear-elliptic, 40–50μ long × 8–10μ wide, with broadly rounded poles; raphe straight with a one-sided central pore; axial area narrow, central area fairly large, elliptic; striae distinctly radial, 12–14 in 10μ, coarsely punctate, but the punctae coalescing to give each stria a longitudinal line effect. (Pl. XI, fig. e).

MALAYA Malacca: Fish-pond, Lorong Pandan, Malacca.

Described from Asia, including Indonesia.

139. **Navicula subtilissima** P. T. Cleve. Valves linear, 20–25μ long × 3–5μ wide, with capitate poles; axial area narrow, central area only slightly wider; striae fine, only slightly radial, more than 40 in 10μ, hardly visible except in the middle where they are slightly wider apart. (Pl. XII, fig. i).

MALAYA Negri Sembilan: Swamps at Port Dickson.
Malacca: Fish-ponds and swamps.
Johore: Swamps at Yong Peng.
Singapore: Swamps.
Probably widespread.

Cosmopolitan.

140. **Navicula tenera** Hustedt. [Syn.: *Navicula uniseriata* Hustedt.] Valves elliptic, 13–18μ long × 6–8μ wide, with broadly rounded poles; raphe straight, central poles rather wide apart, axial area lanceolate, asymmetric with a row of punctae on one side of the raphe ending at the central pore; transverse striae radial, 16–18 in 10μ, broken on each side by a longitudinal hylaine curved line parallel to the margin. (Pl. IX, figs. g & m).

MALAYA Pahang: Stream near Kuantan.

Described from Indonesia.

A very characteristic form with the asymmetrical row of punctae.

141. **Navicula toornensis** P. T. Cleve. Valves small, 17–18μ long × 7–9μ wide, rhombic-elliptic with hardly rostrate, rounded poles; axial area narrow, central area small, hardly wider than the axial area; striae radial, 14–16 in 10μ, distinctly punctate, punctae about 14 in 10μ. (Pl. XI, fig. a1).

MALAYA Pahang: Stream near Kuantan.

N. Europe in lightly brackish to freshwater.

142. **Navicula tridentula** Krasske. Valves small, 11–14μ long × 2–3μ wide, linear lanceolate with distinctly triundulate margins narrowing to the rounded rostrate poles; axial area narrow linear, widening in the middle and sometimes almost reaching the margins; transverse striae extremely fine, not distinguishable even under phase contrast. (Pl. XII, fig. j).

MALAYA Malacca: Swamps.

Widespread in boggy regions.

143. **Navicula trituberculata** Prowse **sp. nov.** Valves elliptic, 20μ long × 10μ wide, laterally sinuate, three-humped on each side, attenuate and rounded at the poles; raphe straight; axial area

narrow, in the middle expanded to form a stauros; striae 18–19 in 10μ, distinctly radial, the central ones being shorter. (Pl. XI, fig. b1).

MALAYA Pahang: Stream near Kuantan. (Type locality).

Holotype Prowse No. 582e is deposited at the Tropical Fish Culture Research Institute, Malacca, Federation of Malaya.

Valvae ellipticae, lateraliter sinuatae utrinque trituberculatae, apice utrinque attenuatae, rotundatae, 20μ longae, 10μ latae. Raphe recta; area axialis angusta medio stauro-formiter ampliata; striae 18–19 in 10μ, manifeste radiales, in centro breviores.

MALAYA Pahang: in fluvio proximo urbe Kuantan.

PINNULARIA Ehrenberg 1840

Cells solitary and free-floating, rarely in short filaments, symmetric and rectangular in girdle view, girdle smooth, without intercalary bands; valves usually with straight or nearly straight sides, sometimes medianly inflated or undulate, usually with broadly rounded poles; axial field usually broad, expanded both at the poles and in the middle, with a complex sigmoid or straight raphe; face of valve crossed by distinct transverse costae with internal openings; costae smooth, radial or parallel (usually convergent at the poles, and with two longitudinal lines often visible in the costate part of the valve; chromatophores two, laminate, usually with pyrenoids.

144. **Pinnularia appendiculata** (C. A. Agardh) P. T. Cleve var. **budensis** Grunow. [Syn.: *Frustulia appendiculata* C.A. Ag.] Valves lanceolate, 40μ long × 8–9μ wide, slightly convex on the margins, slightly constricted below the sub-capitate poles; axial area narrow but broadening to a lanceolate central area, with a wide stauros reaching the margins; raphe straight, curved slightly only at the polar and central nodules; costae distinctly radial, convergent at the poles, 18–20 in 10μ. (Pl. XIV, fig. k).

MALAYA Pahang: Cameron Highlands.

Cosmopolitan.

145. **Pinnularia biceps** Gregory var. **minor** (Boye Petersen) A. Cleve. [Syn. *Pinnularia interrupta* W. Smith f. *minor* Boye Petersen, *Pinnularia interrupta* W. Smith v. *stauroneiformis* Hustedt.]. Valves linear, 30–35μ long × 7–8μ wide, with straight margins sharply narrowed to the sub-capitate poles; axial area narrow, widening to a lanceolate central area with a very wide stauros reaching the margins; costae radial, convergent at the poles, 14–16 in 10μ. (Pl. XIV, fig. m).

MALAYA Malacca: Fish-ponds and the Malacca River.

Cosmopolitan.

146. **Pinnularia bogotensis** (Grunow) P. T. Cleve var. **continua** A. Cleve. [Syn.: *Navicula bogotensis* Grun.]. Valves linear, 90–100μ long × 13–15μ wide, with the middle slightly swollen, ends straight, poles broadly rounded; raphe straight, doubly forked at the polar nodules; axial area narrow, central area wide, elliptic; costae radial, convergent at the poles, 14–16 in 10μ. (Pl. XIV, fig. h).

MALAYA Malacca: Fish-ponds.

Cosmopolitan.

147. **Pinnularia borealis** Ehrenberg. Valves linear-elliptic. 40–45μ long × 9–10μ wide, with broadly rounded poles; raphe slightly curved, with one sided central pores and bifurcate at the poles; axial area narrow, slightly widened in the middle; costae practically parallel, shorter in the middle, very thick, 4–6 in 10μ. (Pl. XIV, fig. q).

MALAYA Malacca: Malacca River.

Widespread in freshwaters.

148. **Pinnularia braunii** (Grunow) P. T. Cleve. [Syn.: *Navicula braunii* Grun.]. Valves elliptic-lanceolate, 65–70μ long × 10–12μ wide, narrowing slightly below the sub-capitate poles; raphe straight, axial area more or less wide lanceolate, widening to the margin in the centre to form a wide stauros with very short lateral arms; costae radial, convergent at the poles shorter near the middle, 10–12 in 10μ. (Pl. XIV, fig. a).

MALAYA Perak: Taiping lakes.
Pahang: Cameron Highlands.
Malacca: Fish-ponds.
Probably widespread in Malaya.

Cosmopolitan.

149. **Pinnularia braunii** (Grunow) P. T. Cleve var. **amphicephala** (Mayer) Hustedt. [Syn. *Pinnularia amphicephala* Mayer.]. Valves linear-lanceolate, 35–75μ long × 8–11μ wide, with less convex margins and more capitate poles than the type; axial area wide, lanceolate, central area a wide stauros with short lateral limbs; costae radial, convergent at the poles, shorter near the middle, 10–14 in 10μ. (Pl. XIV, fig. l; Pl. XV, fig. e).

MALAYA Perak: Taiping lakes.
Pahang: Cameron Highlands.
Malacca: Fish-ponds.
Probably widespread in Malaya.

Cosmopolitan.

150. **Pinnularia brébissonii** (Kuetzing) P. T. Cleve var. **hybrida** (Grunow) A. Cleve. [Syn.: *Navicula brebissonii* Kuetz., *Navicula bicapitata* (Lagerstedt) P. T. Cleve var. *hybrida* Grunow.]. Valves linear elliptic, 25–30μ long × 7–9μ wide, with slightly convex margin narrowing sharply to the subrostate poles; axial area narrow, widening in the middle to a stauros reaching the margins; costae radial in the middle, convergent at the poles, 9–13 in 10μ. (Pl. XIV, fig. o).

MALAYA Perak: Taiping lakes.

Distribution worldwide.

151. **Pinnularia brevicostata** P. T. Cleve. Valves linear, 90–100μ long × 18–20μ wide, with broadly rounded poles; axial area very wide, much more than 1/3 width of the valve, lanceolate; costae short, marginal, parallel to very slightly radial, 8–10 in 10μ. Pl. XV, fig. g).

MALAYA Perak: Taiping lakes.

Widespread in distribution.

152. **Pinnularia gibba** W. Smith var. **interrupta** A. Cleve-Euler. Valves narrow linear-lanceolate, 65–70μ long × 8–10μ wide, slightly swollen in the middle and tapering gradually to the broadly sub-capitate poles; raphe linear, hooked at the poles; axial area narrow, widening slightly towards the middle where it reaches the margin over a wide area; transverse costae radial in the middle, becoming parallel nearer the poles and convergent at the apices, 9–11 in 10μ. (Pl. XIV, fig. b).

MALAYA Perak: Taiping lakes.

Distribution worldwide.

153. **Pinnularia hemiptera** (Kuetzing) Rabenhorst. [Syn.: *Navicula hemiptera* Kuetzing, *Pinnularia hemiptera* Mayer, *Pinnularia hybrida* A. Cleve.]. Valves linear-lanceolate, 65–70μ long × 12–15μ wide, narrowing slightly to the rounded poles; raphe linear, hooked at the poles; axial area lanceolate, about 1/3 width of the valve; costae parallel to very slightly radial, convergent at the poles, 8–12 in 10μ. (Pl. XV, fig. c).

MALAYA Perak: Taiping lakes.

Widespread in distribution.

154. **Pinnularia legumen** Ehrenberg. Valves linear, 70–75μ long × 12–15μ wide, with triundulate margins, narrowing below the broadly capitate poles; raphe slightly curved, hooked at the poles, curved to one side at central pores; axial area wide, about 1/3 width of the valve, central area large, rhombic, almost reaching the margins; costae markedly radial in the middle, convergent at the poles, 8–12 in 10μ. (Pl. VIII, fig. e).

MALAYA Perak: Taiping lakes.

Worldwide in distribution.

155. **Pinnularia macilenta** (Ehrenberg) P. T. Cleve. [Syn.: *Navicula macilenta* Ehr.]. Valves linear, 130–170μ long × 20–25μ wide, with broadly rounded poles and parallel margins; raphe wide, bifurcate at the poles, polar areas circular; axial area wide, linear, about 1/3 the width of the valve; costae parallel, 7–9 in 10μ, crossed on each side by a longitudinal band. (Pl. XVIII, fig. f).

MALAYA Malacca: Malacca River.

Widespread in distribution.

156. **Pinnularia mesolepta** (Ehrenberg) W. Smith. [Syn.: *Navicula mesolepta* Ehrenberg.]. Valves linear, 100–115μ long × 18–20μ wide, with markedly triundulate margins, slightly wider in the middle, and with broadly capitate poles; raphe straight, bifurcate at the poles, polar areas circular; axial area narrow linear, central area round rhombic, not reaching the margins; transverse costae radial, shorter in the middle, convergent at the poles, 10–13 in 10μ. (Pl. XVI, fig. p).

MALAYA Perak: Taiping lakes.

Widspread in distribution.

The Malayan forms are much larger than the type, and in the specimens so far examined have alternating short and long costae opposite the middle of the central area. It remains to be seen whether these differences are sufficiently consistent to warrant separation of these forms as a distinct variety.

157. **Pinnularia microstauron** (Ehrenberg) P. T. Cleve. [Syn.: *Stauroneis microstauron* Ehr.]. Valves linear to linear lanceolate, 50–70μ long × 10–14μ wide, with parallel or slightly convex margins narrowing to subrostrate rounded poles; axial area narrow, linear, widening near the middle to a lanceolate area reaching the margins, forming a stauros; costae radial in the middle, convergent at the poles, 10–13 in 10μ. (Pl. XIV, figs. c & e).

MALAYA Malacca: Fish-ponds and the Malacca River.

Widespread in distribution.

158. **Pinnularia microstauron** (Ehrenberg) P. T. Cleve var. **ambigua** Meister. Differing from the type in that the margins are slightly triundulate, and the poles more markedly rostrate; valves 75–80μ long × 14–16μ wide; transverse costae 10–13 in 10μ. (Pl. XIV, fig. d).

MALAYA Malacca: Malacca River.

Widespread in distribution.

159. **Pinnularia microstauron** (Ehrenberg) P. T. Cleve var. **brébissonii** (Kuetzing) Hustedt. [Syn. *Navicula brébissonii* Kuetz. pro parte.]. Valves linear elliptic with only slightly convex sides, tapering very smoothly to the non-rostrate poles, 60μ long × 10μ wide; axial and central area as in type; costae as in type, 10–13 in 10μ. (Pl. XIV, fig. f).

MALAYA Malacca: Malacca River.

Widespread in freshwaters.

160. **Pinnularia parva** (Gregory) P. T. Cleve var. **parvula** (Ralfs) A. Cleve-Euler. [Syn.: *Navicula parvula* Ralfs, *Pinnularia parvula* (Ralfs) A. Cleve, *Pinnularia parva* Gregory.]. Valves lanceolate, 50μ long × 10μ wide, with subrostrate poles; raphe narrow, hooked at the poles; axial area wide, rhombic lanceolate; costae slightly radial in the middle, convergent at the poles, 9–11 in 10μ. (Pl. XV, fig. b).

MALAYA Perak: Taiping lakes.

Widespread in freshwaters.

161. **Pinnularia polyonca** (Brébisson) P. T. Cleve. [Syn.: *Navicula polyonca* Brébisson, *Pinnularia mesolepta* (Ehr.) W. Smith var. *polyonca* (Bréb.) Cleve, *Navicula mesolepta* Ehr.]. Valves lanceolate, 85–90μ long × 12–15μ wide, a triundulate margin, distinctly swollen in the middle, and slightly constricted beneath the capitate poles; raphe narrow, bifurcate at the poles and with distinct central pores; axial area wide, lanceolate, central area a wide stauros reaching the margins; costae radial in the middle, convergent at the poles, 10–12 in 10μ. (Pl. XVI, fig. o).

MALAYA Malacca: Malacca River.

Widespread in freshwaters.

162. **Pinnularia stauroptera** (Grunow) P. T. Cleve var. **subparallela** Mayer. [Syn.: *Navicula stauroptera* Grun.]. Valves linear, 95–100μ long × 11–14μ wide, with parallel margins slightly constricted beneath the sub-capitate poles; raphe straight, slightly forked at the poles, and curved at the central pores, axial area fairly wide, 1/3 valve width, central area rhombic, reaching the margins to form a stauros; costae radial in the middle, convergent at the poles, 10–11 in 10μ. (Pl. XV, fig. f).

MALAYA Perak: Taiping lakes.

European freshwaters, not common.

163. **Pinnularia stomatophoroides** Mayer var. **nuda** A. Cleve-Euler. Valves sub-linear, 90–95μ long × 14–15μ wide, with triundulate margins, slightly broader in the middle and slightly constricted below the rounded sub-capitate poles; raphe straight,

forked at the poles, central pores conspicuous; axial area about 1/3 valve width, central area rhombic, reaching the lateral margins over a narrow area; costae markedly radial in the middle, convergent at the poles, 10–11 in 10μ (Pl. XV, fig. a).

MALAYA Perak: Taiping lakes.

European freshwaters, not common.

164. **Pinnularia stricta** Hustedt. Valves linear, 18–30μ long × 6–7μ wide, with almost straight margins, sometimes very slightly concave, and broadly rounded poles; raphe straight, curved to one side at the central pores; axial area narrow, widening in a lanceolate manner to the very wide stauros reaching the lateral margins; costae strictly parallel, 12–14 in 10μ. (Pl. XIV, figs. i, j & p).

MALAYA Pahang: Cameron Highlands.

Described from Indonesia.

165. **Pinnularia tabellaria** Ehrenberg. Valves linear, 85–90μ long × 10–13μ wide, slightly swollen in the middle, with sub-capitate poles; raphe straight, hooked at the poles, curved to one side at the central pores; axial area moderately wide, ¼–1/3 valve width, central area elliptic; costae slightly radial in the middle, convergent at the poles, 12–14 in 10μ. (Pl. XIV, fig. g).

MALAYA Perak: Taiping lakes.

Tropical freshwaters.

166. **Pinnularia trigonocephala** P. T. Cleve. Valves large, linear, 130–140μ long × 25–28μ wide, slightly wider in the middle and at the slightly wedgeshaped, sub-capitate poles; raphe straight, forked at the poles, and with one sided central pores; axial area less than ¼ valve width, widening in the middle to the elliptic central area; costae radial in the middle, convergent at the poles, 7–8 in 10μ. (Pl. XV, fig. d).

MALAYA Malacca: Malacca River.

Worldwide in distribution, but not common.

AMPHORA Ehrenberg 1840

Cells usually sessile; girdle view broadly elliptic with truncate ends, the concave faces of the valves being attached, girdles usually separated by several punctate or striate intercalary bands; valve view lunate, longitudinally asymmetric; striae transverse, punctate, with a strongly excentric axial field nearer the concave margin; raphe usually nearer the concave margin, with central nodule almost adjacent to the margin; chromatophores single or 2–4.

Auxospores formed in pairs between two conjugating cells, or formed singly by the union of gametes in a single cell.

167. **Amphora acutiuscula** Kuetzing. [Syn.: *Amphora lineata* Gregory, *Amphora coffaeiformis* C. A. Agardh var. *salinarum* Grunow, *Amphora coffaeiformis* C. A. Agardh var. *acutiuscula* (Kuetzing) Grunow.]. Cells in girdle view elliptic, narrowed slightly before the truncate ends, girdle with several intercalary bands which are striated, 18–20 striae in 10μ; valve semi-lanceolate, 30–60μ long × 6–8μ wide, with only a slightly concave to straight ventral margin, dorsal margin moderately convex, narrowing slightly below the sub-capitate poles; raphe close to the ventral margin, axial area narrow; dorsal striae finely punctate, 14–18 in 10μ, ventral striae short and fine, closer together. (Pl. XVII, figs. e, f, n, q, v & w; Pl. XVIII, fig. b).

MALAYA Pahang: Stream near Kuantan.

Widespread in brackish water, but here found in non-saline water.

168. **Amphora angusta** (Gregory) P. T. Cleve emend. Cells in girdle view elliptic-lanceolate, with narrowly rounded ends and without intercalary bands; valve semi-lanceolate, 18–40μ long × 2–4μ wide, with acute poles, ventral face only slightly concave, valve resembling *Cymbella;* raphe straight, close to ventral face, axial area wider on the dorsal side of the raphe; dorsal striae 15–17 in 10μ, ventral striae very short, more or less equal in number to the dorsal striae. (Pl. XVII, figs. g & i; Pl. XVIII, fig. g).

MALAYA Pahang: Stream near Kuantan.

Usually regarded as marine but here found in non-saline water.

169. **Amphora bitumida** Prowse **sp. nov.** Frustules in girdle view broadly elliptic, 18–23μ long × 11–12μ wide in the middle, ends truncate, 3–4μ wide, under each pole slightly arcuate; girdle with many intercalary bands; valves lunate, 18–23μ long × 5–6μ wide in the middle, markedly convex on the dorsal side, ventrally distinctly tumid and slightly concave opposite the central nodule, poles rostrate to almost subcapitate; raphe simple, not sigmoid, axial area narrow on the dorsal side, sometimes slightly wider near the central nodule, wider and semi-lanceolate on the ventral side, widest in the middle; dorsal striae 17–18 in 10μ, radiate, punctate, ventral striae short, fine 22–25 in 10μ. (Pl. XVII, figs. a, b & c).

MALAYA Pahang: Stream near Kuantan. (Type locality).

Holotype Prowse No. 582f is deposited at the Tropical Fish Culture Research Institute, Malacca, Federation of Malaya.

Frustula aspectu zonali lato-elliptica, apice utrinque truncata 3–4μ lata, infra apicem singulam arcuatiuscula, 18–23μ longa, medio 11–12μ lata, laciniae intercalares plures. Valvae lunate, 18–

23μ longae, medio amplissimae 5–6μ latae, dorso fortiter convexae, ventre manifeste tumidae et nodulum centralem adversus concaviusculae, apice utrinque rostratae, fere capitellatae.

Raphe simplex, haud sigmoidea; area centralis dorso angusta, interdum apud nodulum centralem latiuscula, ventraliter latior, semi-lanceolata, medio latissima. Striae dorsales 17–18 in 10μ, radiatae, punctatae; eae ventrales breves, graciles 22–25 in 10μ.

MALAYA Pahang: in fluvio proximo urbe Kuantan.

170. **Amphora coffaeiformis** C. A. Agardh. Cells in girdle view elliptic, slightly narrowed below the truncate ends, girdles with several intercalary bands; valves lunate, 25–30μ long × 4–6μ wide; with slightly concave ventral margin and convex dorsal margin narrowed slightly below the rostrate poles; axial field very narrow, raphe straight, near the ventral margin; dorsal striae 20–24 in 10μ, ventral striae very short and fine. (Pl. XVII, fig. h & o).

MALAYA Pahang: Stream near Kuantan.

Widespread, generally in brackish waters.

171. **Amphora exigua** Gregory. Cells in girdle view lanceolate, slightly narrowed before the rounded-truncate ends, girdles with several intercalary bands which are finely striate; valve view semi-lanceolate, 25–30μ long × 6–7μ wide, with a straight to slightly convex ventral margin and a convex dorsal margin, both sides being slightly arcuate beneath the sub-capitate poles; axial area narrow, raphe straight, close to the ventral margin; dorsal striae slightly radial, 11–13 in 10μ, punctate, ventral striae very short, fine and closer together, absent opposite the central nodule. (Pl. XVII, fig. d).

MALAYA Pahang: Stream near Kuantan.

A so-called marine species here found in freshwater. It has been recorded from brackish water in S. Africa (Cholnoky 1959).

172. **Amphora holsatica** Hustedt. Cells in girdle view elliptic-lanceolate, slightly narrowing before the truncate ends, girdles with several intercalary bands which are coarsely punctate; valve semi-lanceolate, 40–45μ long × 7–9μ wide, ventral margin straight or nearly so, dorsal side convex, both sides slightly narrowing to the small sub-capitate poles; raphe close to the ventral margin, straight; dorsal striae coarsely punctate, 12–13 in 10μ, punctate about 12 in 10μ, ventral striae very short and fine, closer together, absent opposite the central nodule. (Pl. XVII, fig. m).

MALAYA Pahang: Stream near Kuantan.

Widespread, usually in brackish water.

173. **Amphora holsatica** Hustedt var. **malayana** Prowse **var. nov.** Differing from the type by the punctae of the dorsal striae united into lines nearer the raphe, elsewhere distinct, and below each stria a dot separated by a hyaline gap. (Pl. XVII, fig. l).

MALAYA Pahang: Stream near Kuantan. (Type locality).

Holotype Prowse No. 582g is deposited at the Tropical Fish Culture Research Institute, Malacca, Federation of Malaya.

A forma typica haec varietas differt punctis striarum dorsalium alioqui distinctis, raphen versus in lineas unitis et infra unasquisque lineas punctis singulis per intervallos conspicous sejunctis.

174. **Amphora libica** Ehrenberg. [Syn.: *Amphora ovalis* Kuetz. var. *libica* P. T. Cleve.]. Cells in girdle view elliptic, with truncate ends; valve view lunate, 20–25μ long × 6–7μ wide, with concave ventral margin, convex dorsal margin, tapering gradually to the rounded poles; raphe near the ventral margin, curving very slightly towards the dorsal margin at the central nodule; dorsal striae punctate, 15–18 in 10μ, much shorter near the central nodule, ventral striae short, shortest at the middle, fine and closer together. (Pl. XVII, fig. p).

MALAYA Pahang: Stream near Kuantan.

Widespread in distribution.

175. **Amphora normani** Rabenhorst. Cells in girdle view long-elliptic, slightly narrowed below the truncate ends, girdles with several fine intercalary bands; valve view lunate, 30–40μ long × 8–10 μ wide, slightly constricted below the broad sub-capitate poles; raphe some distance away from the ventral margin, leaving a wide space, central nodule curving dorsalwards, dorsal axial area very narrow; dorsal striae radial, 17 in 10μ, shorter opposite the central nodule, ventral striae very short. (Pl. XVII, fig. r).

MALAYA Pahang: Stream near Kuantan.

Widespread in freshwaters.

176. **Amphora perpusilla** Grunow. Cell very small, in girdle view elliptic, 8–12μ long × 4–5μ wide, in the present form very slightly constricted in the middle; valve view lunate, 8–12μ long × 1½–2μ wide, with convex dorsal side, with a very shallow kink in the middle, ventral side straight or hardly concave; raphe straight, close to the ventral margin; axial area on dorsal side very narrow, central area unmarked; dorsal striae 20–24 in 10μ slightly radial, and slightly wider apart in the middle, ventral margin smooth. (Pl. XVII, fig. j).

MALAYA Pahang: Stream near Kuantan.

The Malayan form differs slightly from the type, both in the slight median constriction and in the slightly wider spacing of the striae in the middle. Should these characters prove constant it should be separated as a variety.

177. **Amphora proteus** Gregory. Cells in girdle view linear-elliptic to almost rectangular with lightly convex margins and broad flat truncate ends, girdles without intercalary bands; valve view lunate, 40–60μ long × 7–10μ wide, only slightly curved, with broad rounded poles; raphe in the middle of the valve distinctly curved ventralwards from the poles to the central nodule, and hooked slightly dorsalwards at the central nodule; dorsal striae slightly radial, 10–13 in 10μ, very coarsely punctate, punctae arranged more or less in longitudinal lines as well as in transverse striae occasionally with a hyaline area opposite the central nodule, ventral striae as long similarly punctate and similarly spaced but absent opposite the central nodule. (Pl. XVII, fig. u; Pl. XVIII, fig. a).

MALAYA Pahang: Stream near Kuantan.

Generally regarded as marine, but here definitely in freshwater.

CYMBELLA C. A. Agardh 1830

Cells solitary and free-floating or attached at the ends of gelatinous stalks, or confined in branched gelatinous tubes; girdle view rectangular with smooth girdles, intercalary bands absent; valve view asymmetric, somtimes only slightly so, lunate or more rarely nearly elliptic, rhombic or naviculoid, dorsally convex, ventrally concave, straight or somewhat convex; axial area wide or narrow, nearer the ventral margin, central area with or without dots; raphe curved, with well defined nodules; transverse striations radiate, sometimes crossed by longitudinal lines; chromatophores a single expanded plate.

Auxospores formed in pairs between the conjugating cells.

178. **Cymbella cuspidata** Kuetzing. Valves broadly lanceolate, 35–40μ long × 15–16μ wide, asymmetrical, narrowing beneath the subrostrate poles; raphe almost central, slightly curved, axial area narrow, central area round-rhombic; striae radial, fine, 9–11 in 10μ in the middle, 12–15 in 10μ near the poles. (Pl. XVII, fig. z).

MALAYA Malacca: Malacca River.

Widespread in freshwaters.

179. **Cymbella javanica** Hustedt. Valves lanceolate, 15–20μ long × 4μ wide, asymmetric, with a markedly convex dorsal margin and a slightly convex ventral margin, narrowing slightly beneath the subrostrate poles; raphe hardly curved, axial area narrow, widening in the middle to form a lanceolate area; striae prominent, radial, 11–12 in 10μ, slightly wider apart on the ventral margin. (Pl. XVII, fig. k).

MALAYA Malacca: Malacca River.

Described from Indonesia.

180. **Cymbella kolbei** Hustedt. Valves broadly lanceolate, asymmetric, 25–30μ long × 9–11μ wide, dorsal margin very convex, ventral margin less so, tapering smoothly to the rounded poles; raphe central, slightly curved, axial area narrow, widening near the middle to an elliptic central area; striae finely punctate, 11–12 in 10μ, slightly radial in the middle, more so at the poles; a single puncta in the middle of the central area. (Pl. XVII, fig. y).

MALAYA Malacca: Malacca River, fish-ponds and swamps.

Described from the Middle East and S. Africa, but probably more widespread. The Malayan forms seem to fit best into this species.

181. **Cymbella lanceolata** (Ehrenberg) van Heurck. [Syn.: *Cocconema lanceolata* Ehrenberg.]. Valves distinctly asymmetrical, naviculoid, 70–80μ long × 15–20μ wide, with a convex dorsal margin, and concave ventral margin slightly tumid in the middle, tapering smoothly to the rounded poles; raphe excentric, slightly curved; axial area narrow, widening slightly towards the middle; striae at right angles to the raphe in the middle, radial at the poles, 9–11 in 10μ, markedly punctate, punctae 15–18 in 10μ. (Pl. XVIII, fig. 1).

MALAYA Malacca: Swampy water.

Widespread in distribution.

182. **Cymbella sumatrensis** Hustedt. Valves broadly lanceolate, 35–40μ long × 9–10μ wide, distinctly asymmetric, with a very convex dorsal margin and a less convex ventral margin, tapering to the blunt, rounded poles; raphe nearly central, slightly convex towards the dorsal margin; axial area narrow, widening in the middle to form an elliptic central area; striae coarsely punctate, radial, in the middle of the dorsal side 10 in 10μ, closer together near the poles and on the ventral sides; a single isolated pore opposite the middle ventral stria. (Pl. XVIII, fig. h).

MALAYA Malacca: Malacca River.

Described from Indonesia.

183. **Cymbella tumida** (Brébisson) van Heurck. [Syn.: *Cocconema tumidum* Brébisson, *Cocconema stomatophorum* Grunow.]. Valves broadly lunate, 50–70μ long × 18–20μ wide, with a very convex dorsal margin, ventral margin straight or slightly concave, swollen in the middle region, narrowing slightly at the ends beneath the broad, blunt poles; raphe almost central, a little nearer the ventral margin, slightly curved; axial area linear, widening in the middle to the large, broadly rounded central area; striae coarsely punctate, radial, 8–10 in 10μ in the middle of the dorsal side, closer together elsewhere; a single large pore in the middle of the ventral half of the central area. (Pl. XVII, fig. a1).

MALAYA Pahang: Cameron Highlands.
Selangor: Gombak River.

Widespread in freshwaters.

A very characteristic species.

184. **Cymbella turgida** Gregory. [Syn.: *Encyonema turgidum* (Greg.) Grunow.]. Valves lunate, 35–40μ long × 11–12μ wide, with a very convex dorsal margin and a straight ventral margin, with more or less sub-acute poles; raphe excentric, straight except at the poles, where it curves sharply towards the ventral margin; axial area narrow, linear, only slightly wider in the middle; striae on dorsal side radial, 8–10 in 10μ, coarsely punctate, punctae 17–20 in 10μ, on ventral side convergent and closer together. (Pl. XVII, fig. x).

MALAYA Malacca: In a swamp.

Widespread in freshwaters.

185. **Cymbella ventricosa** Kuetzing. Valves lunate, 15–25μ long × 5–7μ wide, with a distinctly convex margin and a straight to slightly convex ventral margin, poles rounded acute; raphe near the ventral margin, straight; axial area narrow, only slightly wider in the middle; striae slightly radial, 14–16 in 10μ, finely punctate. (Pl. XVII, figs. s & t).

MALAYA Pahang: Cameron Highlands.

Widespread in freshwaters.

GOMPHONEMA C. A. Agardh 1824

Cells usually epiphytic on the ends of dichotomously branched gelationous stalks, sometimes sessile, more rarely solitary and free floating; girdle view transversely asymmetrical, cuneate, the narrower end being the point of attachment; valve view also transversely asymmetrical, cuneate, clavate, lanceolate or nearly straight with one pale broader than the other, and often capitate; axial field narrow, straight, with a straight raphe and conspicuous central and polar nodules; striations transverse, parallel or radial; central area sometimes extending to the margins, with an asymmetrically placed dot or pore; chromatophore a single lobed plate, usually with a single pyrenoid.

Auxospores formed in pairs between two conjugating cells.

186. **Gomphonema gracile** Ehrenberg. Valve view rhombic-lanceolate, 40–50μ long × 8–10μ wide, almost isopolar with narrow rounded poles; axial area narrow, linear, with a small roundish central area, with a single isolated pore on one side; striae slightly radial to almost parallel, 12–15 in 10μ, not markedly punctate. (Pl. XVI, figs. a & e).

MALAYA Malacca: Fish-pond.

Widespread in freshwaters.

187. **Gomphonema longiceps** Ehrenberg var. **subclavata** Grunow forma **gracilis** Hustedt. Valves narrow linear rhombic, 65–70μ long × 9–10μ wide, margins slightly concave between the middle and the narrow rounded poles; axial area narrow, central area small, with a short marginal stria on each side and an isolated pore on one side; striae slightly radial, 10–12 in 10μ, lightly punctate. (Pl. XVI, fig. m).

MALAYA Pahang: Cameron Highlands.

Widespread in freshwaters, but not common.

188. **Gomphonema parvulum** (Kuetzing) van Heurck. [Syn.: *Sphenella parvula* Kuetzing.]. Cells small, valves elliptic lanceolate, 15–30μ long × 4–7μ wide, more or less rostrate to subcapitate at the free pole (i.e. not attached to the gelatinous stalk) and slightly constricted above the attached pole; axial area narrow, central area small, one-sided, with a single isolated pore on one side; striae slightly radial to nearly parallel, 13–17 in 10μ, lightly punctate. (Pl. XVI, figs. c, d, g, h & i).

MALAYA Pahang: Cameron Highlands.
Selangor: Gombak River.
Malacca: Swamps.

Widespread in freshwaters. A very variable species of which several varieties have been named. The Malayan material has too many intermediate forms to justify separating any varieties.

189. **Gomphonema subtile** Ehrenberg. Valves slender, narrow-lanceolate, 50–65μ long × 7–8μ wide, convex in the middle but narrowing and slightly concave towards the poles; free pole distinctly broadly capitate, the attached pole narrow, rounded; axial area narrow, central area wider, lanceolate, with shorter

striae on one side, and usually with a single isolated pore, sometimes with more, sometimes with none; striae slightly radial, 12 in 10μ, punctate. (Pl. XVI, figs. b, j, k & l).

MALAYA Perak: Taiping lakes.

Widespread in freshwaters.

The shape is very characteristic, but the usual form has no isolated pore in the central area; in the Malayan material the other forms seem equally common.

190. **Gomphonema subventricosum** Hustedt. Valves lanceolate, 32–40μ long × 7–8μ wide, broadest above the middle, tapering gently towards the subrostrate free pole, narrowing very much below the middle towards the narrowly rounded pole of attachment; axial area narrow, widening slightly in the middle, where the striae are shorter and with a single isolated pore on one side; striae slightly radial, 10–12 in 10μ, markedly punctate, with the punctae drawn out longitudinally. (Pl. XVI, figs. f & n).

MALAYA Selangor: Stream near the Klang Gates Reservoir.

Described from Indonesia.

RHOPALODIA O. Mueller 1895

Cells usually solitary and free-floating; girdle view with two faces, a convex face much wider than the other straight or concave face; girdle view linear, nearly elliptic, clavate or almost rounded, often medianly inflated and sometimes with a median notch; valve view lunate to sickle-shaped, convex margin often inflated, with acute ends, sometimes elongate, surface distinctly ridged towards the convex margin; axial field in valve ridge, with raphe bearing central and polar nodules; both valve and girdle view transversely costate, with intermediate finer striae; intercalary bands present or absent; chromatophores single, laminate, with irregular margins.

Auxospores formed in pairs between two usually different sized cells, elongating perpendicular to the long axis of the cells.

191. **Rhopalodia gibberula** (Ehrenberg) O. Mueller. [Syn.: *Epithemia gibberula* Ehr.]. Girdle view elliptic, 40–45μ long × 22–25μ wide, narrowing to the bluntly rounded ends; valves sickle-shaped with a very convex dorsal margin having a notch in the middle and a slightly concave ventral margin; costae radial, 3–4 in 10μ, each pair with 4–6 striae between them, striae 15–18 in 10μ on the ventral margin. (Pl. XXII, fig. a).

MALAYA Selangor: Stream near Klang Gates Reservoir.

Widespread usually in brackish water, but here in undoubtedly freshwater.

192. **Rhopalodia musculus** (Kuetzing) O. Mueller. [Syn.: *Epithemia musculus* Kuetzing.]. Girdle view broadly elliptic, almost circular, 20μ long × 18μ wide, with broadly rounded poles; valves broadly lunate, with a very convex dorsal margin, ventral margin straight except at the poles where it curves sharply ventralwards; costae 3–4 in 10μ, with 3–5 striae between each pair, striae 16–18 in 10μ on the ventral margin. (Pl. XXII, fig. f).

MALAYA Pahang: Stream near Kuantan.

Widespread, usually in brackish water.

193. **Rhopalodia parallcla** (Grunow) O. Mueller. [Syn.: *Epithemia gibba* Kuetz. var. *parallela* Grunow.]. Girdle view linear, 65–80μ long × 14–15μ wide, with sides nearly parallel and only slightly narrowed at the truncate ends; valves half linear-lanceolate, with a very slightly convex, almost straight dorsal margin, slightly constricted in the middle, and straight ventral margin; costae slightly radial, 6–8 in 10μ, with 2–4 striae between each pair, striae 12–15 in 10μ (Pl. XXII, fig. b).

MALAYA Pahang: Stream near Kuantan.

Widespread, usually in brackish water.

TROPIDONEIS P. T. Cleve 1894

Cells usually solitary and free-floting; girdle view nearly rectangular with a median constriction, to broad hour-glass shaped, a keel curving in on each margin from the poles to the central nodule, intercalary bands present or absent; valve view lanceolate, usually acute at the poles, with the raphe in a wing or keel which may be strictly central, or which may be sigmoid from one pole to the other; axial field narrow, central area small, transverse striae marked, sub-parallel to radial. Chromatophores 2, parallel to the girdle. Mainly a marine genus.

194. **Tropidoneis lepidoptera** (Gregory) P. T. Cleve. [Syn.: *Amphiprora lepidoptera* Gregory.]. Cell in girdle view long-rectangular, 40–80μ long × 23–25μ wide, markedly constricted in the middle, poles truncate, rounded; valves linear-lanceolate, 40–80μ long × 12–15μ wide, with narrowed sub-acute poles; wing containing raphe central, usually seen obliquely slightly to one side of the longitudinal axis; axial field very narrow, central area small, round; transverse striae slightly radial, fine, 16–22 in 10μ. (Pl. XVIII, figs. c, d, e & i).

MALAYA Pahang: Stream near Kuantan.

Usually regarded as marine, but here found in freshwater.

HANTZSCHIA Grunow 1877

Cells curved in both valve and girdle view, thus having a dorsal and ventral margin; girdle view elongate-rectangular, somewhat attenuate; valve view linear-lanceolate to linear, more or less attenuated to rostrate or capitate poles; raphe of each valve in a keel near the ventral margin, so that both keels are on the same side of the longitudinal axis, raphe with circular pores ("carinal dots") opening towards the interior of the cells; valves transversely striate; chromatophore single near one side of the girdle.

195. **Hantzschia amphioxys** (Ehrenberg) Grunow var. **capitata** O. Mueller. [Syn.: *Eunotia amphioxys* Ehr.]. Valves linear-lanceolate, 35–40μ long × 5μ wide, slightly curved, and narrowing to the small capitate poles; carinal pores 8 in 10μ, much wider apart in the middle and with a prominent central nodule; striae 22–25 in 10μ. (Pl. XIX, fig. t).

MALAYA Selangor: Stream near Klang Gates reservoir.

Widespread in freshwaters.

196. **Hantzschia amphioxys** (Ehrenberg) Grunow var. **vivax** (Hantzsch) Grunow. [Syn.: *Eunotia amphioxys* Ehr., *Nitzschia vivax* Hantzsch, *Nitzschia elongata* Hantz. var. *minor* Mayer.]. Valves linear, 180–225μ long × 10μ wide, slightly curved and attenuated to the sub-acute rostrate poles, ventral margin constricted in the middle; carinal pores 6 in 10μ, central nodule prominent, striae 18–20 in 10μ. (Pl. XIX, fig. r).

MALAYA Malacca: Malacca River.

Widespread in freshwaters.

NITZSCHIA Hassall 1845

Cells solitary and free-floating or densely clustered in simple or unbranched gelatinous tubes; girdle view elongate-rectangular, or sigmoid, with somewhat attenuated poles; valves usually longitudinally asymmetric, rarely symmetric, very variable in shape, straight, sigmoid, linear, elliptic, sometimes undulate, with or without median constriction, poles acute, rostrate or capitate, often much attenuate; raphe in keel which is usually near one margin, rarely central with small nodules and a row of carinal dots opening towards the interior of the cell, keels of the two valves on opposite sides of the longitudinal axis, except where the keel is central; valve transversely striate or punctate and sometimes costate.

Two auxospores formed by the conjugation of two cells in somewhat crossed opposition.

197. **Nitzschia acicularis** (Kuetzing) W. Smith. [Syn.: *Synedra acicularis* Kuetzing.]. Valves 60–65μ long × 5μ wide, spindle-shaped with markedly attenuate straight ends; carinal pores small, 12–16 in 10μ, transverse striae more than 30 in 10μ, very fine, only just visible with phase contrast. (Pl. XIX, fig. m).

MALAYA Malacca: Swampy rice field.

Widespread in freshwater.

198. **Nitzschia amphibia** Grunow var. **acutiuscula** Grunow. Cells small, valves 18–22μ long × 4μ wide, lanceolate with acute, wedge-shaped poles; carinal pores small, 7–9 in 10μ, transverse striae 17–20 in 10μ, punctate. (Pl. XIX, fig. g).

MALAYA Malacca: Fish-ponds.

Widespread in fresh to brackish water.

199. **Nitzschia closterium** (Ehrenberg) W. Smith. [Syn.: *Ceratoneis closterium* Ehr.]. Valves 35–40μ long × 2–3μ wide, spindle-shaped in the middle, but curved in a sickle shape with very long narrow attenuated ends; carinal pores 15–16 in 10μ, transverse striae extremely fine and hardly visible. (Pl. XX, fig. n).

MALAYA Pahang: Stream near Kuantan.

Usually reported from brackish or sea water, but here in freshwater.

A very characteristic form.

200. **Nitzschia communis** Rabenhorst var. **abbreviata** Grunow. Cells very small, valves 6–8μ long × 2.5–3μ wide, elliptic with narrow rounded poles; carinal pores 12–14 in 10μ, with a gap in the middle, striae fine, 30 in 10μ. (Pl. XIX, fig. j).

MALAYA Pahang: Stream near Kuantan.

Widespread.

201. **Nitzschia constricta** (Gregory) Grunow. [Syn.: *Tryblionella constricta* Greg.]. Valves linear-elliptic, 18–22μ long × 8–9μ wide, with slightly constricted margins and wedge-shaped poles; carinal pores small, 10 in 10μ striae 16–20 in 10μ, distinctly punctate, the punctae forming oblique lines sloping in opposite directions to the longitudinal axis. (Pl. XIX, fig. d).

MALAYA Pahang: Stream near Kuantan.

Usually regarded as marine.

202. **Nitzschia diducta** Hustedt. Valves broadly linear, 38–40μ long × 7–8μ wide, with slightly concave to parallel margins, wedge-shaped ends, and narrow rounded, almost acute poles; carinal pores 8–10 in 10μ, wider apart in the middle; transverse striae well marked, 30 in 10μ. (Pl. XIX, fig. x).

MALAYA Pahang: Stream near Kuantan.

Described from Indonesia.

203. **Nitzschia fonticola** Grunow. Cells small, valves 12–15μ long × 2–4μ wide, lanceolate, narrowing to the sub-rostrate to sub-acute poles; carinal pores 12–14 in 10μ, transverse striae fine but clearly visible, 28–30 in 10μ. (Pl. XIX, figs. a, b & c).

MALAYA Negri Sembilan: fish-ponds.
Malacca: fish-ponds, Malacca River.

Widespread throughout the world.

204. **Nitzschia gandersheimiensis** Krasske. Valves linear, 90–100μ long × 4μ wide, slightly narrowing to the rounded, hardly rostrate poles; carinal pores very irregular, 8–9 in 10μ, transverse striae very fine, just visible with phase contrast, more than 30 in 10μ. (Pl. XIX, fig. u).

MALAYA Malacca: Fish-ponds in Malacca and the Malacca River.

Widespread.

205. **Nitzschia granulata** Grunow. Valve elliptic-lanceolate, 20μ long × 11μ wide, with rounded poles; carinal pores 7–8 in 10μ, transverse striae 7–8 in 10μ, with very coarse punctate, 6 in 10μ. (Pl. XIX, fig. i).

MALAYA Pahang: Stream near Kuantan.

Usually regarded as marine.

Cleve-Euler (1952) mentions very short marginal double rows of fine punctae as well as the coarse ones. These were not visible in the Malayan material, which agrees in all other respects. It would however be very difficult to see the fine punctae in a complete specimen, since the coarse punctae of one valve would hide the fine punctae in the others. I was not able to observe single valves, only complete frustules.

206. **Nitzschia heufleuriana** Grunow. Valves linear, 90–100μ long × 4–5μ wide, often slightly curved and distinctly constricted beneath the capitate poles; carinal pores 9–10 in 10μ, slightly wider apart in the middle, transverse striae prominent, 15–20 in 10μ. (Pl. XIX, fig. v).

MALAYA Malacca: Swamp in Malacca.

Widespread.

207. **Nitzschia ignorata** Krasske. Cell in girdle view linear, sigmoid; valve view linear-lanceolate, 60–70μ long × 4μ wide, distinctly sigmoid and narrowing evenly to the rounded poles; keel very excentric, slightly kinked in the middle; carinal pores 7–10 in 10μ, wider in the middle, transverse striae fine, about 30 in 10μ. (Pl. XIX, fig. s).

MALAYA Malacca: Malacca River.

Widespread, usually in brackish water.

208. **Nitzschia littoralis** Grunow var. **tergestina** Grunow. Valves broad linear-elliptic, 28–30μ long × 9–10μ wide, with parallel to slightly concave margins and wedge shaped ends tapering to rounded sub-rostrate poles; carinal pores 7–8 in 10μ with a distinct central nodule; transverse striae 20 in 10μ, with a central narrow, lanceolate, clear longitudinal field less than 1/3 width of the valve. (Pl. XX, fig. k).

MALAYA Pahang: Stream near Kuantan.

Usually found in brackish water.

This may be identical with *Nitzschia calida* Grunow.

209. **Nitzschia lorenziana** Grunow var. **subtilis** Grunow. Valve long, linear-lanceolate, 100–110μ long × 4–5μ wide, distinctly sigmoid with curved ends tapering to the narrow rounded poles; keel excentric, carinal pores 8 in 10μ, transverse striae 20 in 10μ. (Pl. XIX, fig. q).

MALAYA Malacca: Malacca River.

Widespread in fresh to slightly brackish water.

210. **Nitzschia marginulata** Grunow. Valve broad linear, 100–110μ long × 18–20μ wide, with wedge-shape ends tapering to narrow, rounded poles; carinal pores 9–10 in 10μ, striae 19–22 in 10μ, punctate, valve face with a very broad, smooth, linear-lanceolate central area stretching from pole to pole. (Pl. XXI, fig. b).

MALAYA Pahang: Stream near Kuantan.

Usually found in brackish water.

211. **Nitzschia microcephala** Grunow. Valves linear, 10–15μ long × 2.5–3μ wide, with parallel or slightly convex margins, sharply narrowed to slightly attenuate sub-capitate poles; carinal pores 12–14 in 10μ, transverse striae fine, 32–36 in 10μ. (Pl. XIX, fig. f).

MALAYA Pahang: Stream near Kuantan.

Widespread in freshwaters, but not common, possibly overlooked because of its small size.

212. **Nitzschia navicularis** (Brébisson) Grunow. [Syn.: *Surirella navicularis* Bréb.]. Valves elliptic, 30–35μ long × 15–16μ wide, with smoothly rounded poles; carinal pores 7–8 in 10μ; valve face with marginal transverse costae and a central longitudinal clear area lanceolate in shape, two rows of alternating punctae on each costae, costae 7–8 in 10μ. (Pl. XX, fig. o).

MALAYA Pahang: Stream near Kuantan.

Usually marine or in brackish water. The Malayan specimens have slightly longer costae than the type, but there is no doubt that they belong under this species.

213. **Nitzschia obtusa** W. Smith. Cells long linear, slightly sigmoid; valves linear, 180–230μ long × 10–11μ wide, very slightly constricted in the middle, ends rounded sometimes slightly wedge-shaped, curving slightly to one side to make the valve slightly sigmoid; keel excentric, notched in the middle with a prominent central nodule, carinal pores 5–8 in 10μ, transverse striae fine, 26 in 10μ. (Pl. XX, fig. c).

Malaya Pahang: Stream near Kuantan.

Usually in brackish water or marine.

214. **Nitzschia obtusa** W. Smith var. **scalpelliformis** Grunow. Much smaller than the type, and with a very sharp convex curve on one side of each end so that the actual pole is narrow and sometimes almost acute; valves 25–80μ long × 4–5μ wide; carinal pores 8–9 in 10μ, central nodule less well-marked, transverse striae 28–30 in 10μ. (Pl. XIX, fig. o; Pl. XX, fig. d).

Malaya Pahang: Stream near Kuantan.

Marine or in brackish water.

215. **Nitzschia palea** (Kuetzing) W. Smith. [Syn.: *Synedra palea* Kuetz.]. Valves linear, 30–50μ long × 3–5μ wide, with ends narrowing to the hardly sub-rostrate to sub-capitate poles; carianl pores 10–14 in 10μ, transverse striae very fine 33–40 in 10μ. (Pl. XIX, fig. k).

Malaya Perak: Taiping lakes.
Pahang: Cameron Highlands.
Malacca: Fish-ponds and Malacca River.
Probably widespread.

Common throughout the world in freshwaters.

216. **Nitzschia parvula** Lewis. [Syn.: *Nitzschia obtusa* W. Smith var. *brevissima* Grunow.]. Cells small, linear-rectangular in girdle view, hardly sigmoid; valve view linear, 30–40μ long × 4–5μ wide, slightly constricted in the middle, narrowing at the ends to the rostrate poles, which curve in opposite drections making the valve slightly sigmoid; carinal pores 6–8 in 10μ, transverse striae 29–30 in 10μ. (Pl. XIX, fig. h).

Malaya Pahang: Cameron Highlands.

Europe in fresh to slightly brackish water.

217. **Nitzschia paradoxa** (Gmelin) Grunow. [Syn.: *Bacillaria paradoxa* Gmelin.]. Cells united valve face to valve face to form ribbons which zigzag by one cell gliding longitudinally on the next; girdle view linear-rectangular, valve view linear, 60–90μ

long × 5–8μ wide, narrowing in a wedge-shape to the subacute poles; keel central, carinal pores 8–9 in 10μ, transverse striae 20–24 in 10μ. (Pl. XX, fig. b; Pl. XXI, fig. d).

MALAYA Malacca: Malacca River.

Widespread, usually in brackish water but has been reported from freshwater elsewhere.

This is better known as *Bacillaria paradoxa* Gmelin, the genus *Bacillaria* having been erected on the basis of the central keel. In *Nitzschia* there are several intergrades from the extreme excentric position, and it seems rational to include this group under *Nitzschia*. The peculiar zigzag gliding motion makes this species easy to identify and serves to distinguish it from all other species, including those with centrally placed keels.

218. **Nitzschia plana** W. Smith. Valves linear, 80–90μ long × 12μ wide, slightly narrowed in the middle and with wedge-shaped poles; keel very excentric, carinal pores 4–6 in 10μ; transverse striae 18–22 in 10μ, with a linear central area about 1/3 width of valve. (Pl. XX, fig. e).

MALAYA Pahang: Stream near Kuantan.

Found in brackish to freshwater as well as in the sea, but not common.

219. **Nitzschia punctata** (W. Smith) Grunow var **apiculata** A. Cleve-Euler. [Syn.: *Tryblionella punctata* W. Smith.]. Valves elliptic, 20–25μ long × 12–13μ wide, narrowed at the ends to the apiculate poles; keel excentric, carinal pores 8–9 in 10μ, not marked; transverse striae marked, 9–10 in 10μ, curving near the poles, and almost like costae in appearance. (Pl. XIX, fig. w).

MALAYA Pahang: Stream near Kuantan.

Brackish water in Europe, not common.

220. **Nitzschia punctata** (W. Smith) Grunow var. **malayana** Prowse **var. nov.** Differs from the type in being broad, with concave margins and broad wedge-shaped ends.

Valves broadly lanceolate, 31μ long × 21μ wide, almost hexagonal, with slightly concave margins and broad wedge-shaped ends; keel very excentric, carinal pores 8 in 10μ; transverse striae prominent, punctate, slightly radial from central line of valve, 14–16 in 10μ. (Pl. XX, fig. h).

MALAYA Pahang: Stream near Kuantan. (Type locality).

Holotype Prowse No. 582h is deposited at the Tropical Fish Culture Research Institute, Malacca, Federation of Malaya.

A forma typica haec varieties differt natura latissima, cum marginibus concavis et apicibus latis cuneatis.

Valvae late lanceolate, 31μ longae, 21μ latae, fere hexagonales, marginibus concavulus et apicibus latis cuneatis. Carina valde excentrica, dentibus 8 in 10μ. Striae transversales prominentes, punctatae, ab axi centrale radiusculae, 14–16 in 10μ.

MALAYA Pahang, in fluvio.

221. **Nitzschia romana** Grunow. Valves lanceolate to linear-lanceolate, 20–35μ long × 4–5μ wide, tapering evenly at the ends to the acute poles; carinal pores 11–13 in 10μ, not very prominent, transverse striae 24–26 in 10μ. (Pl. XX, figs. i & j).

MALAYA Pahang: Stream near Kuantan.

Widespread in freshwaters.

222. **Nitzschia scalaris** (Ehrenberg) W. Smith. [Syn.: *Synedra scalaris* Ehr.]. Cells very long, valves linear, 450–500μ long × 16–17μ wide, with wedge-shaped poles, very slightly hooked to one side; carinal pores prominent, irregular, drawn out transversely to irregular lengths, 3–5 in 10μ, transverse striae prominent, fine punctate, 9–11 in 10μ. (Pl. XX, fig. g).

MALAYA Pahang: Stream near Kuantan.

Usually marine or brackish.

This is a very characteristic species and one of the largest.

223. **Nitzschia sigma** (Kuetzing) W. Smith. [Syn.: *Synedra sigma* Kuetz.]. Cell in girdle view sigmoid with somewhat narrowed ends; valves linear, 60–100μ long × 3–5μ wide, tapering to the narrow poles; more or less sigmoid; keel excentric, carinal pores 7–10 in 10μ, transverse striae 24–28 in 10μ. (Pl. XX, figs. a & m).

MALAYA Pahang: Stream near Kuantan.

Widespread in both brackish and freshwater.

The smaller forms have often been separated off as var. *rigidula* Grun., but the differences are not really sufficient to merit such a separation.

224. **Nitzschia sigma** (Kuetzing) W. Smith var. **clausii** (Hantzsch) Grunow. [Syn.: *Nitzschia clausii* Hantzsch.]. Cells much shorter; valves linear, 40μ long × 4μ wide, with parallel or slightly concave margins narrowed at the ends to the short rostrate poles, which point in opposite directions making the valve slightly sigmoid; carinal pores 10–11 in 10μ, transverse striae very fine, more than 30 in 10μ. (Pl. XIX, fig. l).

MALAYA Malacca: Malacca River.

Widespread in both brackish and fresh water.

225. **Nitzschia stagnorum** Rabenhorst. Cells in girdle view linear with parallel, slightly convex or slightly concave margins and truncate ends; valve view linear, 40–45μ long × 6μ wide, tapering at the ends to the rostrate or sub-rostrate poles; keel narrow, carinal pores 7–9 in 10μ, transverse striae 25–26 in 10μ. (Pl. XIX, fig. n).

MALAYA Malacca: Swamps and the Malacca River.

Widespread in freshwaters.

226. **Nitzschia subtilis** (Kuetzing) Grunow. [Syn.: *Synedra subtilis* Kuetz.]. Valves linear-lanceolate, 90–130μ long × 3–5μ wide, evenly narrowed to the almost acute poles; keel excentric, carinal pores 8–10 in 10μ, transverse striae 28–32 in 10μ. (Pl. XIX, fig. p; Pl. XX, fig. f).

MALAYA Malacca: Malacca River and fish-ponds.

Widespread in fresh water.

227. **Nitzschia surirelloidea** Prowse **sp. nov.** Valves broadly linear, 270–280μ long × 18μ wide, long sub-cuneate towards both poles, slightly narrowed towards the middle; keel very excentric; valve face with costae, striae prominent, solitary in each costa, 5 in 10μ, reaching almost to the central axis; punctae very weak, 9–10 in 10μ; carinal pores (teeth) as many as the striae 5–10μ; central area narrow. (Pl. XXI, fig. e).

MALAYA Malacca: Malacca River (Type locality).

Holotype Prowse No. 198a is deposited at the Tropical Fish Culture Research Institute, Malacca, Federation of Malaya.

Superficially this resembles *Surirella,* but is very long and narrow. The one keel on each valve clearly distinguishes it as a *Nitzschia.*

Valvae late lineares, 270–280μ longae, 18μ latae, apicem versus utrinque longae subcuneatae, medium versus paululo angustatae. Carina valde excentrica. Striae prominentes, in unaquaque costa solitariae, 5 in 10μ, fere axin centralem attingentes; punctis indistinctis, 9–10 in 10μ; dentibus quot striae, 5 in 10μ. Area centralis angusta.

Superficialiter aspectum *Surirellae* accedens, sed haec species longissima ac angustissima.

MALAYA Malacca, in fluvio.

228. **Nitzschia towutensis** Hustedt. Valves small, elliptic, 12–15μ long × 4–6μ wide, with distinctly convex sides and short narrow rostrate poles; keel very excentric, carinal pores small, 15–16 in 10μ, transverse striae fine, 28–30 in 10μ. (Pl. XIX, figs. y & z; Pl. XX, fig. l).

MALAYA Pahang: Stream near Kuantan.

Described from Celebes.

229. **Nitzschia tryblionella** Hantzsch var. **victoriae** Grunow. Valves broad, linear-elliptic, 35–40μ long × 16–17μ wide, with concave margins and broad wedge-shaped ends; face of valve costate, costae slightly radial from central line of valve, 5–6 in 10μ; keel very excentric, carinal pores 7–9 in 10μ, transverse striae very fine, hardly visible, even with phase contrast. (Pl. XIX, fig. e).

MALAYA Pahang: Stream near Kuantan.

Widespread in both brackish and fresh water, but not common.

STENOPTEROBIA Brébisson 1867

Cells long, linear, sigmoid; valves linear with a very narrow wing on both margins containing raphes, each wing containing a series of canals connecting to the interior ("wing canals") separated by semi-circular membranes; thus each valve has two raphes; face of valve with transverse striae and a central pseudo raphe.

230. **Stenopterobia intermedia** (Lewis) Fricke. [Syn.: *Surirella intermedia* Lewis.]. Valve long, linear, 110–130μ long × 6–8μ wide, sigmoid and tapering gently near the ends to the rounded poles; wing canals 4–5 in 10μ, transverse striae 20–24 in 10μ. (Pl. XXI, fig. a).

MALAYA Malacca: Malacca River.

Widespread in freshwaters.

SURIRELLA Turpin 1828

Cells solitary and free-floating; valves elongate, lanceolate, elliptic or ovate, longitudinally symmetrical, transversely symmetrical or asymmetrical, valve face flat, undulate or curved; girdle view rectangular, sinuate or irregular; raphe in a prominent keel or wing on each margin of the valve, connected by a series of canals opening to the interior ("wing canals") separated by semi-circular membranes, valve face with costae corresponding to the wing canals; chromatophore single, laminate or appearing as two expanded lobes.

231. **Surirella angusta** Kuetzing. Cells in girdle view rectangular with nearly flat ends, valve view isopolar, linear, 30–50μ long × 9–10μ wide, with parallel sides, and wedge-shaped ends; valve wing narrow; costae 6–7 in 10μ, reaching almost to the middle line, costae and intercostal regions about as wide as each other. (Pl. XXIII, figs. b & i).

MALAYA Pahang: Cameron Highlands.

Widespread in freshwaters.

232. **Surirella angusticostata** Hustedt. Cells isopolar, girdle view linear rectangular with curved corners and flat ends; valve view elliptic-lanceolate, 75–80μ long × 19–20μ wide, tapering to more or less wedge-shaped poles; wing narrow, wing canals small, costae very narrow, 4–5 in 10μ, much narrower than the intercostal region and reaching the middle line. (Pl. XXIII, fig. c).

MALAYA Pahang: Cameron Highlands.

Described from Sumatra.

233. **Surirella biseriata** Brébisson. Cells very large, isopolar, in girdle view rectangular with rounded ends; valve view linear to elliptic-lanceolate, 200–370μ long × 50–80μ wide, with parallel or slightly convex sides and somewhat wedge-shaped poles; wings prominent, costae 10–18 in 100μ, almost reaching the middle line, radial at the poles, costae and intercostal areas equidistant. (Pl. XXII, fig. d).

MALAYA Malacca: Malacca River and swamps near Malacca town.

Widespread in freshwater.

234. **Surirella capronii** Brébisson. Cells large, heteropolar, in girdle view broadly wedge-shaped; valve view ovate, 160–200μ long × 60–80μ wide, with bluntly rounded poles; wing very prominent, costae 10–15 in 100μ, nearly reaching the middle line, radial at the ends, intercostal area narrower than the costae; a prominent bulbous-based spine near each end on the middle line. (Pl. XXII, fig. e).

MALAYA Malacca: Malacca River.

Widespread in freshwaters.

An unmistakable species.

235. **Surirella lemmermanni** Hustedt. Cells medium large, valve view slightly heteropolar, lanceolate, 90–100μ × long 20μ wide, with keel-shaped ends tapering to narrow poles; wing narrow, costae 55–70 in 100μ, reaching the middle line and radial at the ends, costae much wider than the intercostal areas. (Pl. XXII, fig. c).

MALAYA Malacca: Malacca River.

Widespread in freshwaters, but not common.

236. **Surirella linearis** W. Smith. Cells isopolar; valves linear, 40–100μ long × 12–20μ wide, with parallel or slightly convex sides and bluntly rounded sub-cuneate ends; wing usually well-marked, costae 20–40 in 100μ, wider than the intercostal distances, almost reaching the middle line, radial at the poles. (Pl. XXIII, figs. g & f; Pl. XXIV, figs. a & c).

MALAYA Penang: Fish-ponds.

Malacca: Malacca River.

Probably widespread in Malaya.

World-wide distribution in freshwaters.

There is some variation in the forms from all parts of the world, and some of the Malayan forms have a higher ratio of costae than usual, but there is so much intergrading that it seems unjustifiable to separate them.

237. **Surirella muelleri** Hustedt. [Syn.: *Surirella constricta* O. Mueller.]. Cells large, isopolar; valve view linear, 200–300μ long × 45–55μ wide, with markedly concave sides and more or less bluntly rounded, wedge-shaped ends; wings not very marked; costae 16–18 in 100μ, about equal in width to the intercostal distance, almost reaching the central line, radial at the poles. (Pl. XXIV, fig. d).

MALAYA Malacca: Malacca River.

Described from Africa.

The Malayan forms agree so closely with those from Africa that it is doubtful if they could be included under any other species.

238. **Surirella robusta** Ehrenberg. Cells large, distinctly heteropolar; in girdle view wedge-shaped with flat ends; valve-view oval-elliptic, 150–250μ long × 50–80μ wide, distinctly heteropolar with blunt rounded ends; wings very marked, costae prominent, 8–15 in 10μ, slightly wider than the intercostal distance, radial at the poles and nearly reaching the middle line. (Pl. XXI, fig. c).

MALAYA Pahang: Cameron Highlands.

Malacca: Malacca River and swamps near Malacca town.

Widespread in freshwaters.

A characteristic form.

239. **Surirella robusta** Ehrenberg var. **splendida** (Ehrenberg) van Heurck. [Syn.: *Navicula splendida* Ehr., *Surirella splendida* W. Smith.]. Cells smaller than the type, with the costae closer together; valves oval-elliptic, 80–120μ long × 25–35μ wide, distinctly heteropolar, with bluntly rounded ends; wings prominent, costae 20–25 in 100μ, nearly reaching the middle. (Pl. XXIII, fig. d, Pl. XXIV, fig. b).

MALAYA Pahang: Cameron Highlands.

Selangor: Gombak River.

Malacca: Malacca River, swamps near Malacca Town.

Widespread in freshwaters.

240. **Surirella spiralis** Kuetzing. Cells isopolar, spirally twisted around the longitudinal axis, in girdle view shaped like a figure 8 with bluntly rounded ends; in valve view linear-elliptic, 50–70μ long × 25–30μ wide, spirally twisted into a figure 8, with with rounded wedge-shaped poles; wings prominent, costae 20–30 in 100μ, wider than the intercostal distance, not reaching the middle line, central area more or less linear-lanceolate. (Pl. XXIII, fig. 1).

MALAYA Malacca: Malacca River, swamps and fish-ponds near Malacca Town.

Probably widespread in Malaya.

Distribution worldwide in freshwaters.

241. **Surirella tenera** Gregory. Cells heteropolar, in girdle view narrow wedge-shaped with truncate ends; valve view linear ovate, 100–130μ long × 25–30μ wide, heteropolar, tapering at the ends to the bluntly rounded poles; wings prominent, costae 20–30 in 100μ, wider than the intercostal distance, radial at the poles, almost reaching the middle line. (Pl. XXIII, fig. e).

MALAYA Malacca: Malacca River.

Described from Africa and reported from Indonesia.

242. **Surirella tenuissima** Hustedt. Cells small, heteropolar, in girdle view narrow wedge-shaped, with bluntly rounded ends; valve view narrow ovate, 18–35μ long × 7.5–11μ wide, heteropolar with rounded truncate poles; wings narrow to moderately marked, costae 40–70 in 100μ, wider than the intercostal distance, reaching or nearly reaching the central line, transverse striae sometimes visible on valve face. (Pl. XXIII, figs. a, h, j & k).

MALAYA Pahang: Cameron Highlands.

Reported from Indonesia and S. America.

CAMPYLODISCUS Ehrenberg 1840

Cells solitary and free-floating, circular or nearly so in outline, or saddle-shaped, bent in valve face, girdle view varying; raphe in a narrow wing round valve margin, valves with radiating costae converging to a hyaline punctate or striate centre; a single broad laminate chromatophore.

243. **Campylodiscus clypeus** W. Smith. Valve medium large, a slightly squarish circle in shape, 45μ in diameter; wing narrow, costae wide, short, marginal, 15–35 in 100μ, radial and subtended by radiating rows of coarse punctae, 7 rows in 10μ, with a large squarish, smooth, central area; valve face undulate bulging in from the costae and out again to the centre, so that some of the punctae appear faint. (Pl. XXII, fig. g).

MALAYA Malacca: Malacca River.

Found in slightly brackish to freshwater in Europe.

Addendum

MASTOGLOIA Thwaites 1856

Cells solitary or in gelatinous tubes, often in structureless gelatinous envelopes; girdle view rectangular, septate with internal part of septa fusiform and divided into chambers; valve view lanceolate, elliptic or rhombic, poles broadly rounded, acute or rostrate, with marginal septa and inner septa divided into a series of submarginal chambers lying in a longitudinal row; axial field narrow, raphe straight, with small central and polar nodules, valve face transversely striate; chromatophores two with extensive lateral projections.

Auxospores formed in pairs by the conjugating of two cells.

244. **Mastogloia exigua** Lewis. Cells small, in girdle view rectangular with flat ends; valve view elliptic lanceolate 20–25μ long × 7–8μ wide, with rounded poles; septum marginal except at the poles, chambers 4 on each side, slightly rounded on the inner side; axial field narrow, striae fine, sub-parallel 20–24 in 10μ. (Pl. XVIII, figs. j & k).

MALAYA Pahang: Stream near Kuantan.

Usually described from brackish water, but here in quite freshwater.

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To Dr. C. F. Hickling, Fisheries Adviser to the Secretary of State for the Colonies of the United Kingdom Government, and first Acting Director of the Tropical Fish Culture Research Institute in Malacca, and to the Colonial Office, I wish to express my thanks for all the encouragement given in this research, and for permission to publish the results. To Mr. H. M. Burkill, Director of the Botanic Gardens, Singapore, I am deeply grateful for all the samples he has collected for me, for affording me facilities for work in the Botanic Gardens in my early days in Singapore, and for permitting this paper to be published in the *Gardens' Bulletin.* I am also very grateful to Dr. D. S. Johnson and students of the Zoology Department in the University of Malaya in Singapore for the algal samples they collected in the Cameron Highlands and elsewhere. To Professor H. B. Gilliland and the Department of Botany at the University of Malaya in Singapore I am extremely grateful for all the encouragement and help in this research which they have afforded me. To the University of Malaya library department I am particularly grateful for the facilities they have given me. I am also very grateful to all those people, too numerous to list here, who have sent me reprints of various papers. To Dr. J. Lund of the Freshwater Biological Association in England I am

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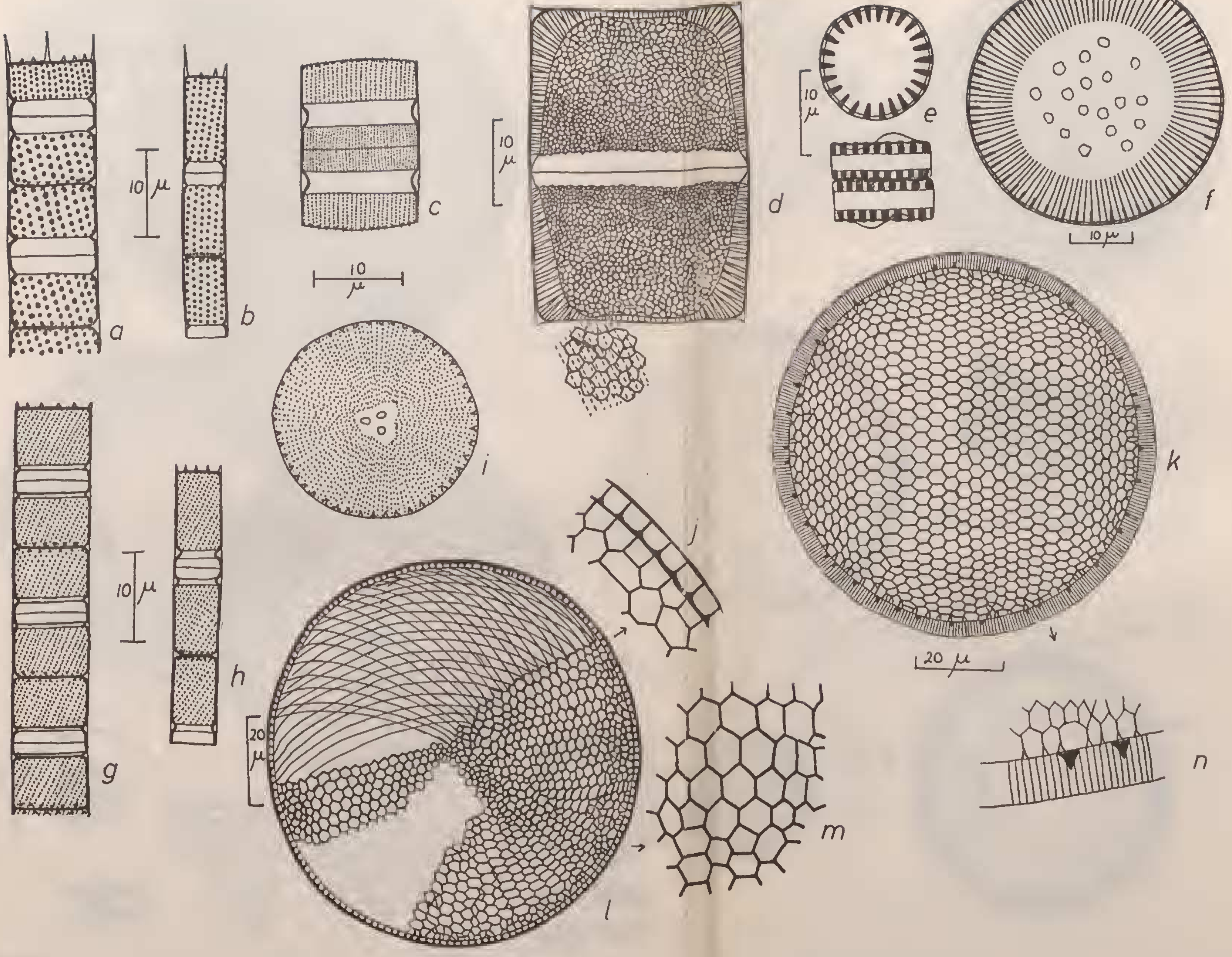

Plate I.

(*a* & *b*) *Melosira granulata* (Ehrenberg) Ralfs; (*c* & *i*) *Melosira roeseana* Rabenhorst; (*d*) *Melosira rüettneri* Hustedt; (*e*) *Cyclotella meneghiniana* Küetzing; (*f*) *Cyclotella striata* (Küetzing) Grunow; (*g* & *h*) *Melosira italica* (Ehrenberg) Küetzing; (*j*, *m* & *l*) *Coscinodiscus argus* Ehrenberg; (*k* & *n*) *Coscinodiscus lineatus* Ehrenberg.

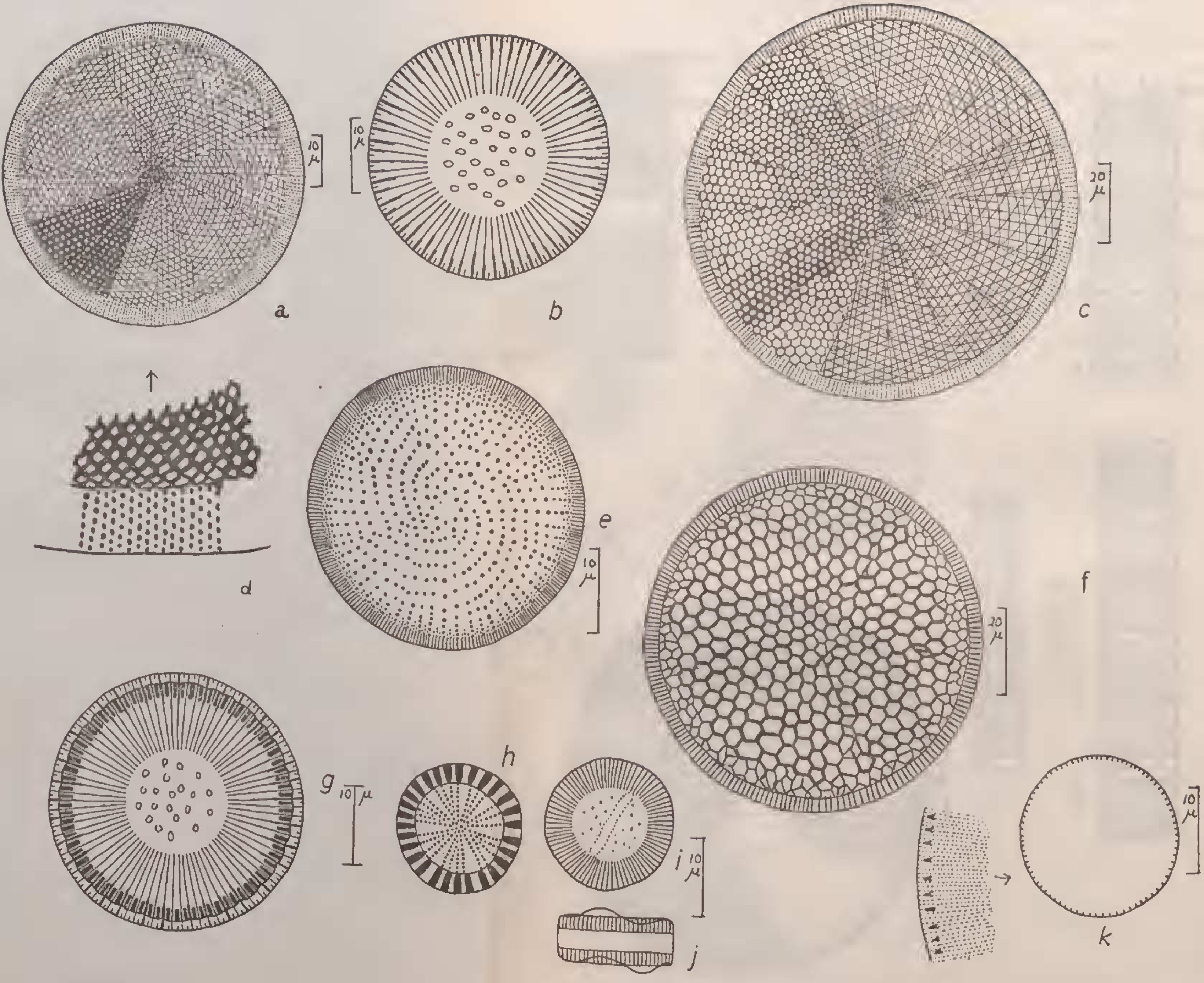

Plate II.

(*a* & *d*) *Coscinodiscus divisus* Grunow; (*b* & *g*) *Cyclotella striata* (Küetzing) Grunow; (*c*) *Coscinodiscus symmetricus* Kitton; (*e*) *Coscinodiscus griseus* Grev. var. *gallopagensis* Grunow; (*f*) *Coscinodiscus antiquus* (Grunow) A. Cleve; (*h*) *Cyclotella meneghiniana* (Küetzing); (*i* & *j*) *Cyclotella küetzingiana* Thwaites; (*k*) *Thalassiosira fluviatilis* Hustedt.

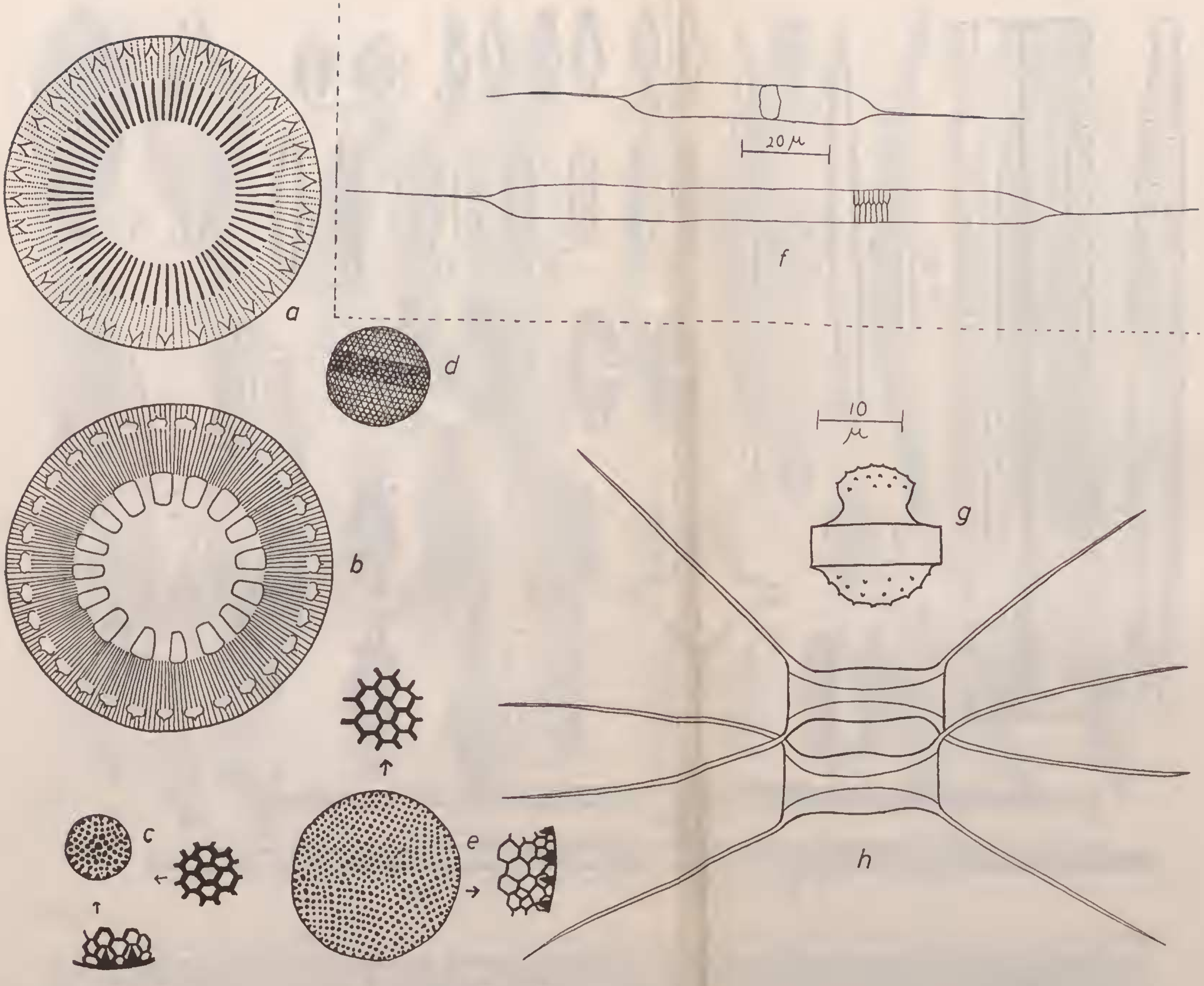

Plate III.

(*a*) *Stephanodiscus biserialis* Prowse *sp. nov.;* (*b*) *Stephanodiscus fenestralis* Prowse *sp. nov.;* (*c*) *Coscinodiscus decipiens* Grunow; (*d*) *Coscinodiscus lineatus* Ehrenberg var. *van heurckii* P. T. Cleve; (*e*) *Coscinodiscus excentricus* Ehrenberg; (*f*) *Rhizosolenia eriensis* H. L. Smith; (*g & h*) *Chaetoceros amanita* A. Cleve.

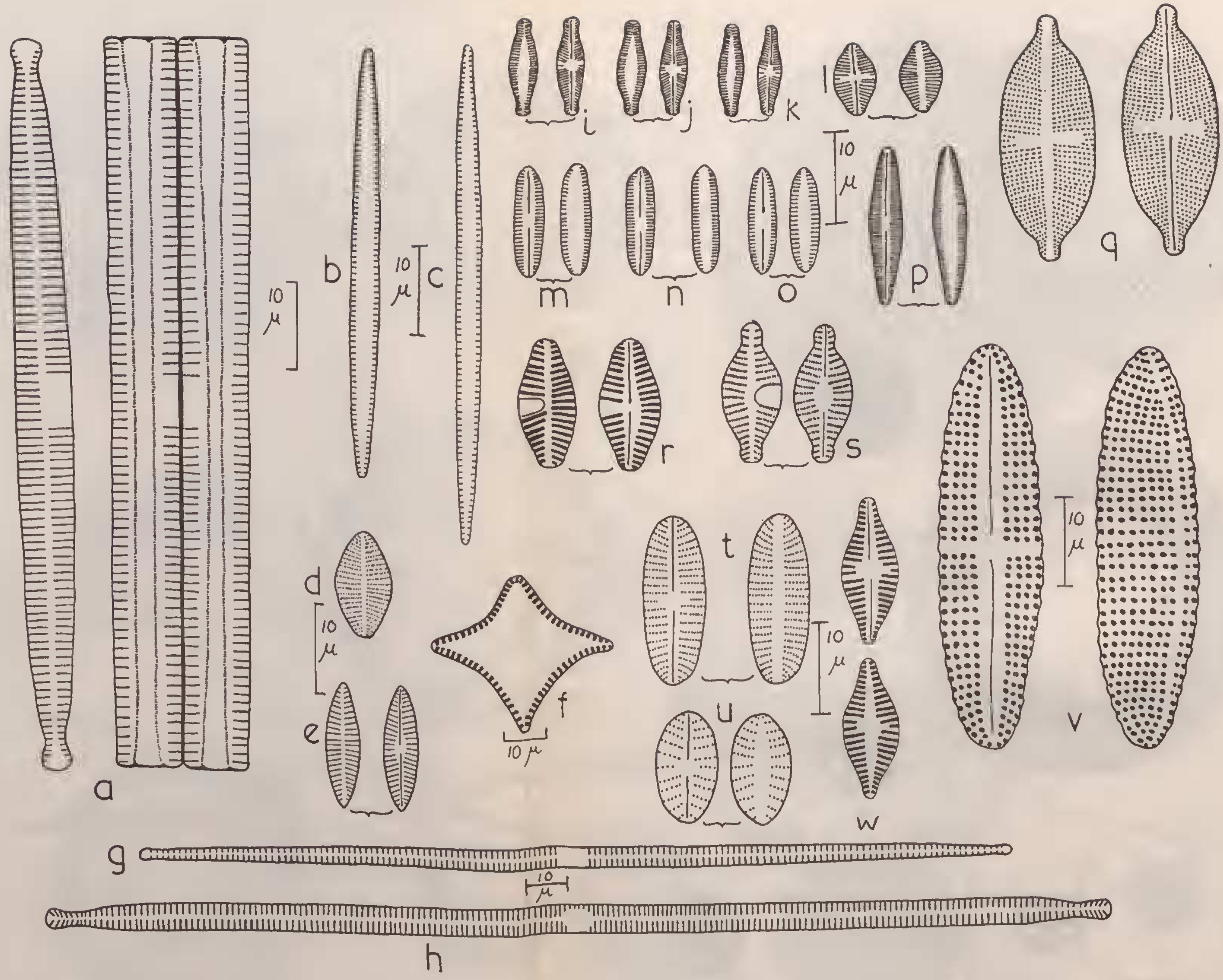

Plate IV.

(*a*) *Fragilaria vaucheriae* (Küetzing) Boye Petersen; (*b* & *c*) *Synedra tabulata* (C. A. Ag.) Küetzing var. *acuminata* (Grunow) Hustedt; (*d*) *Fragilaria virescens* Ralfs. var. *elliptica* Hustedt; (*e*) *Achnanthes subhudsonis* Hustedt; (*f*) *Fragilaria lapponica Grunow* var. *tetragonalis* Prowse *var. nov.*; (*g*) *Synedra ulna* (Nitzsch) Ehrenberg var. *danica* (Küetzing) Grunow; (*h*) *Synedra ulna* (Nitzsch) Ehrenberg var. *amphirhynchus* (Ehrenberg) Grunow; (*i, j* & *k*) *Achnanthes woltereckii* Hustedt; (*l*) *Achnanthes exigua* Grunow; (*m, n* & *o*) *Achnanthes tropica* Hustedt; (*p*) *Achnanthes tenuissima* Hustedt; (*q*) *Achnanthes stauroneiformis* Prowse *sp. nov.*; (*r*) *Achnanthes lanceolata* (Bréb.) Grunow; (*s*) *Achnanthes lanceolata* (Bréb.) Grunow var. *rostrata* Hustedt; (*t* & *u*) *Cocconeis thumensis* A. Mayer; (*v*) *Achnanthes crenulata* Grunow; (*w*) *Achnanthes hauckiana* Grunow var. *rostrata* Schulz.

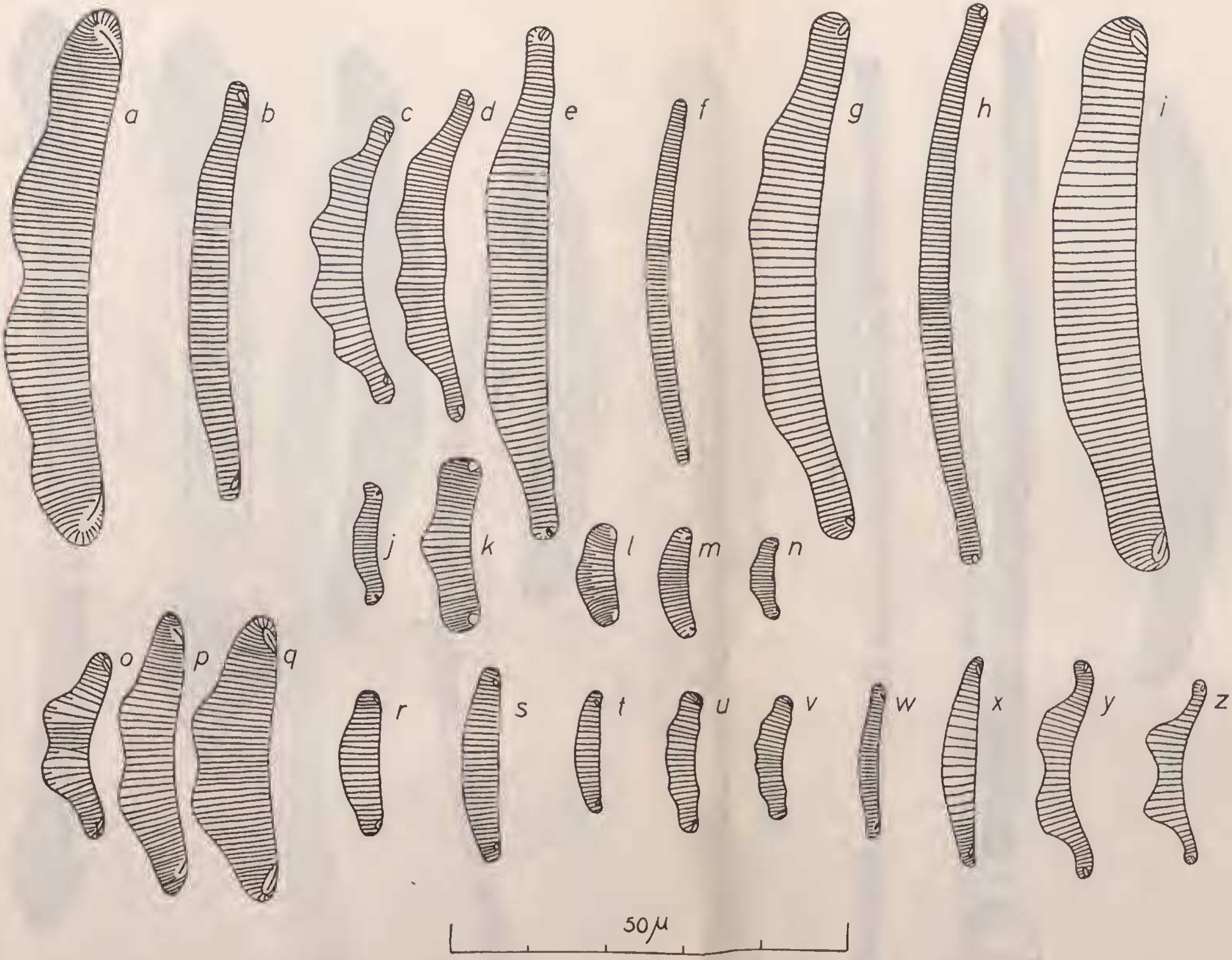

Plate V.

(*a*) *Eunotia monodon.* Ehrenberg var. *constricta* A. Cleve-Euler; (*b*) *Eunotia pectinalis* (Küetzing) Rabenhorst; (*c* & *d*) *Eunotia camelus* Ehrenberg var. *karveerensis* Gandhi; (*e*) *Eunotia grunowi* A. Berg var. *uplandica* A. Cleve f. *subundulata* A. Cleve; (*f*) *Eunotia lunaris* (Ehrenberg) Grunow; (*g*) *Eunotia monodon* Ehrenberg var. *undulata* A. Cleve-Euler; (*h*) *Eunotia lunaris* (Ehrenberg) Grunow var. *capitata* Grunow; (*i*) *Eunotia major* (W. Smith) Rabenhorst var. *indica* (Grunow) A. Berg; (*j*) *Eunotia exigua* (Brébisson) Grunow; (*k*) *Eunotia praemonas* A. Cleve-Euler var. *monodon* (Oestrup) A. Cleve-Euler; (*l* & *r*) *Eunotia praemonas* A. Cleve-Euler var. *inflata* (Grunow). A. Cleve-Euler; (*m*) *Eunotia faba* (Ehrenberg) Grunow var. *densestriata* Oestrup; (*n*) *Eunotia cancellata* A. Berg. var. *esseda* A. Berg; (*o*) *Eunotia sarekensis* A. Cleve-Euler var. *minor* A. Cleve-Euler; (*p* & *q*) *Eunotia diodon Ehrenberg* var. *minor* Grunow; (*s*) *Eunotia monodon Ehrenberg* var. *alpina* Küetzing; (*t* & *x*) *Eunotia sudetica* O. Müeller var. *incisa* (May.) A. Cleve-Euler; (*u* & *v*) *Eunotia polydentula* (Brun) A. Berg var. *perminuta* Grunow; (*w*) *Eunotia pectinalis* (Küetzing) Rabenhorst var. *minor* (Küetzing) Rabenhorst; (*y* & *z*) *Eunotia camelus* Ehrenberg.

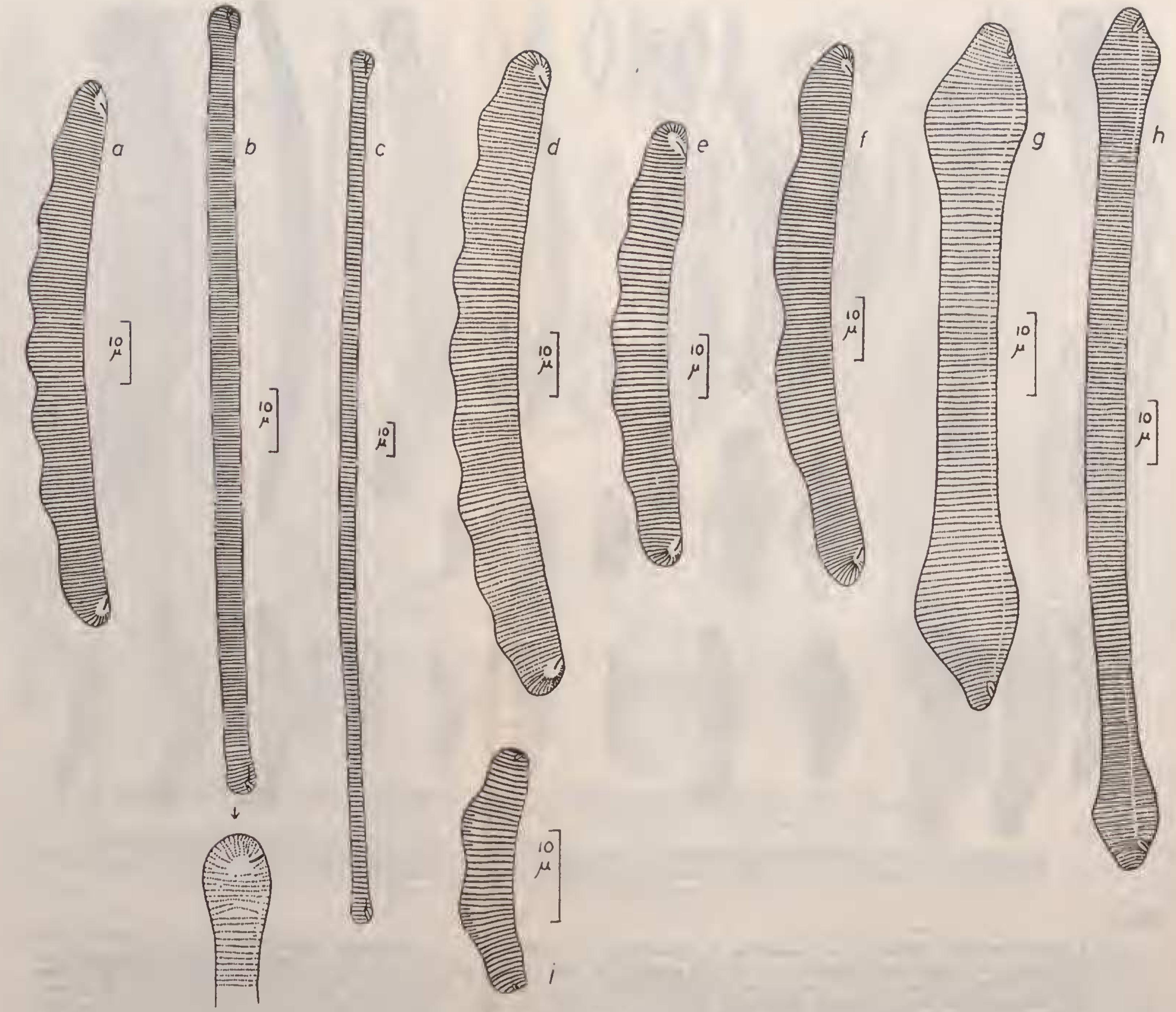

Plate VI.

(*a, d & e*) *Eunotia robusta* Ralfs; (*b & c*) *Eunotia flexuosa* Küetzing; (*f*) *Eunotia major* (W. Smith) Rabenhorst var. *emarginata* A. Cleve; (*g & h*) *Eunotia formica* Ehrenberg; (*i*) *Eunotia praemonos* A. *Cleve-Euler* var. *tibetica* (Mereschk.) A. Cleve-Euler.

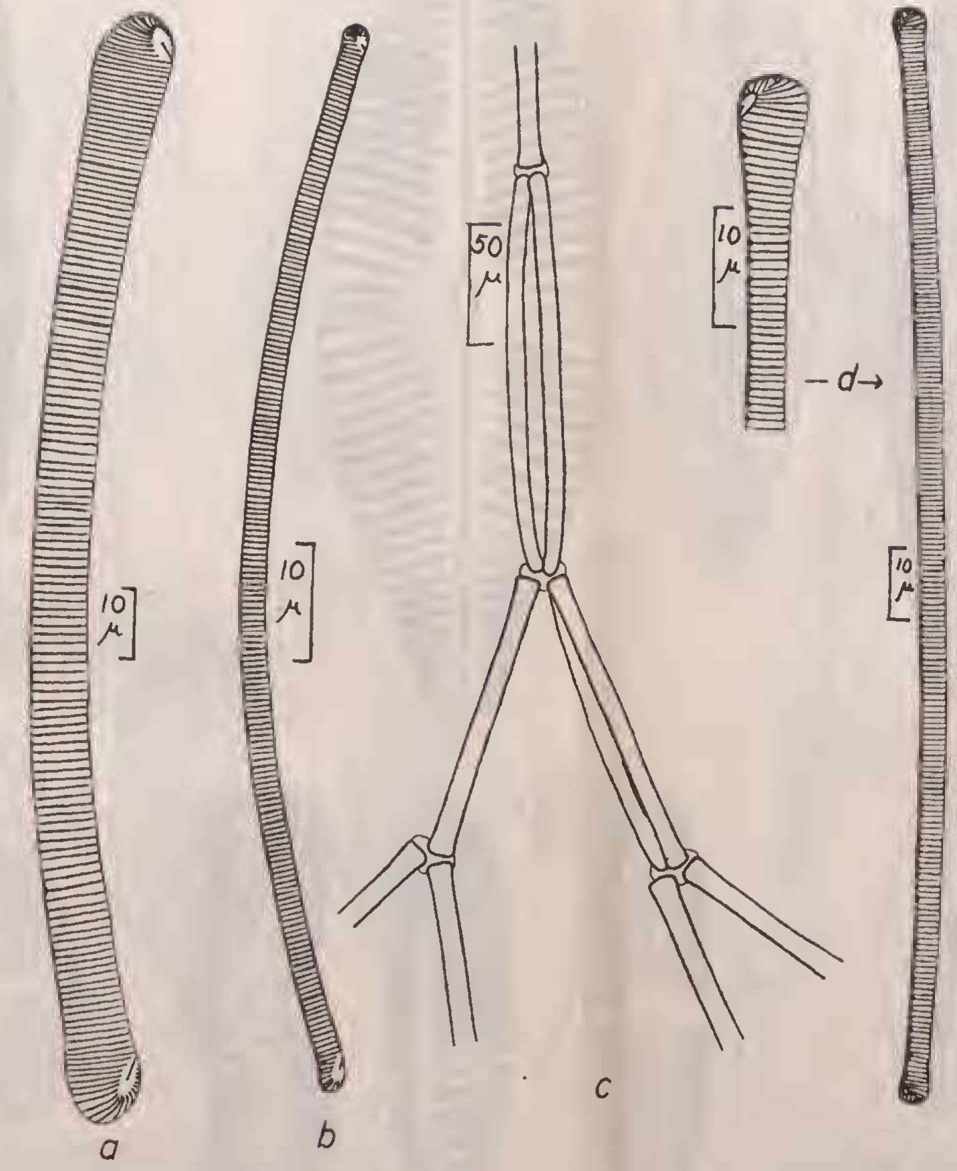

Plate VII.

(*a*) *Eunotia major* (W. Smith) Rabenhorst var. *linearis* A. Cleve; (*b*) *Eunotia gracilis* (Ehrenberg) Rabenhorst; (*c* & *d*) *Desmogonium rabenhorstianum* Grunow; (*c*) general habit of colony.

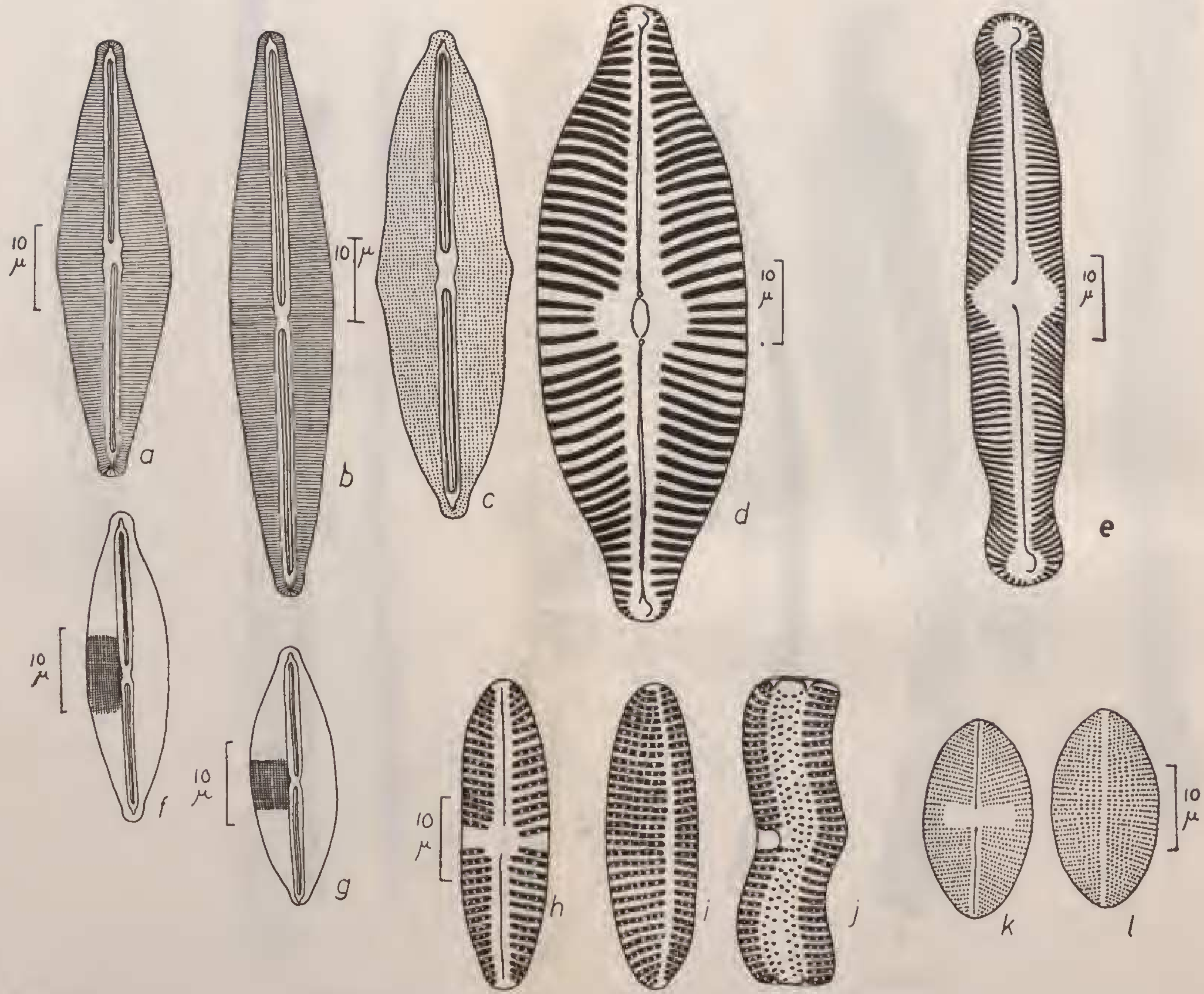

Plate VIII.

(*a* & *b*) *Frustulia rhomboides* (Ehrenberg) de Toni; (*c*) *Frustulia javanica* Hustedt; (*d*) *Navicula elegantoides* Hustedt; (*e*) *Pinnularia legumen* Ehrenberg; (*f* & *g*) *Frustulia saxonica* Rabenhorst; (*h, i* & *j*) *Achnanthes brevipes* C. A. Agardh var. *intermedia* Küetzing; (*k* & *l*) *Cocconeis feuerbornii* Hustedt.

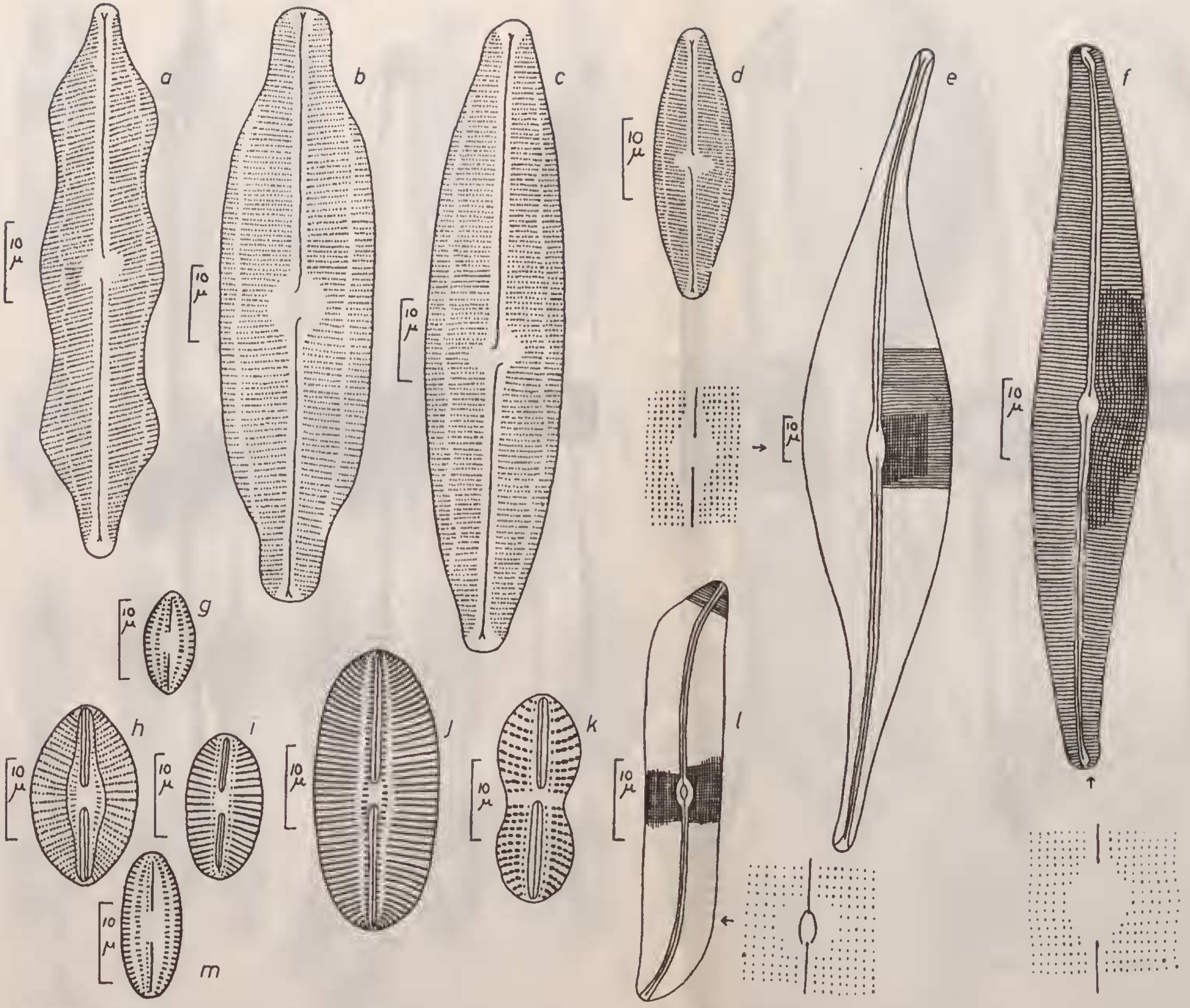

Plate IX.

(*a*) *Neidium hitchcockii* (Ehrenberg) P. T. Cleve; (*b*) *Neidium productum* (W. Smith) P. T. Cleve; (*c* & *d*) *Neidium iridis* (Ehrenberg) P. T. Cleve var. *ampliatum* (Ehrenberg) P. T. Cleve; (*e*) *Gyrosigma distortum* (W. Smith) P. T. Cleve var. *parkeri* (Harrison) P. T. Cleve; (*f*) *Gyrosigma spenceri* (W. Smith) P. T. Cleve var. *smithii* (Grunow) A. Cleve-Euler; (*g* & *m*) *Navicula tenera* Hustedt; (*h*) *Diploneis ovalis* (Hilse) P. T. Cleve; (*i*) *Diploneis decipiens* A. Cleve var. *parallela* A. Cleve; (*j*) *Diploneis oblongella* (Naegeli) P. T. Cleve var. *baltica* A. Cleve; (*k*) *Diploneis interrupta* (Küetzing) P. T. Cleve; (*l*) *Gyrosigma scalproides* (Rabenhorst) P. T. Cleve.

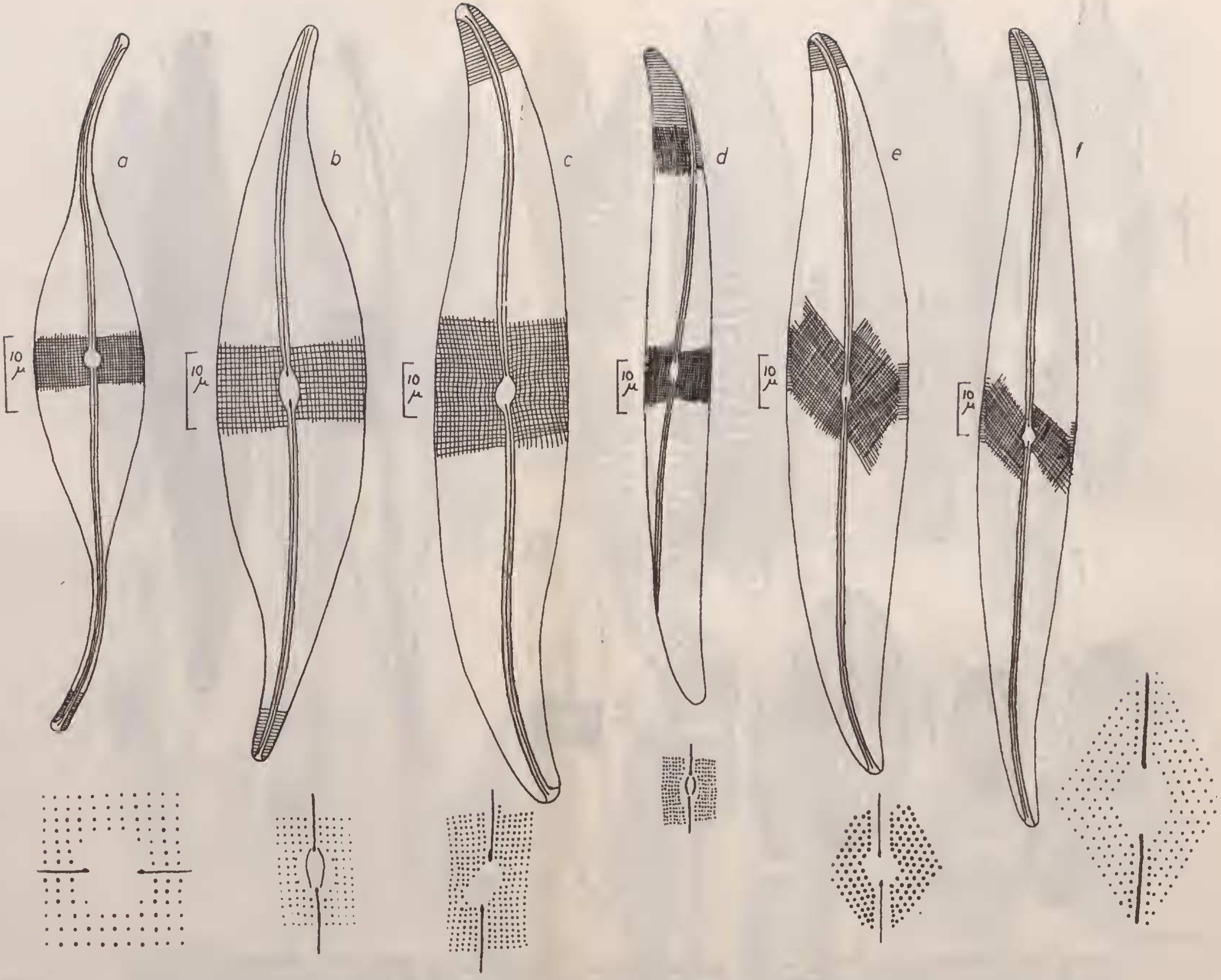

Plate X.

(*a*) *Gyrosigma fasciolum* (Ehrenberg) P. T. Cleve var. *arcuatum* (Donkin) P. T. Cleve; (*b*) *Gyrosigma distortum* (W. Smith) P. T. Cleve; (*c*) *Gyrosigma attenuatum* (Kuetzing) P. T. Cleve; (*d*) *Gyrosigma excentricum* Prowse *sp. nov.*; (*e*) *Pleurosigma salinarum* (Grunow) P. T. Cleve; (*f*) *Pleurosigma elongatum* W. Smith.

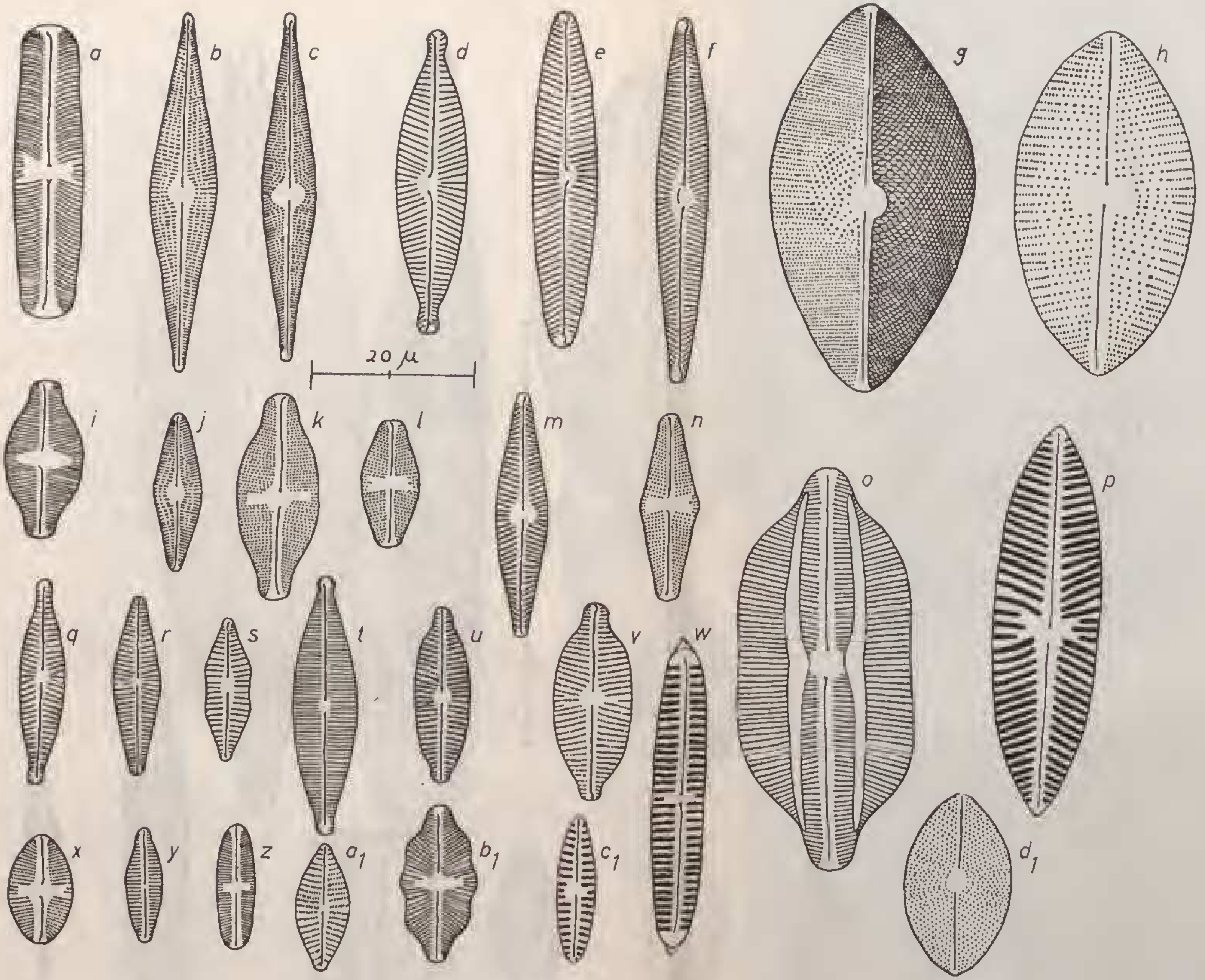

Plate **XI**.

(*a*) *Navicula pupula* Küetzing var. *capitata* Hustedt; (*b* & *c*) *Anomoeoneis serians* (Brébisson) P. T. Cleve var. *acuta* Hustedt; (*d* & *q*) *Navicula rhyncocephala* Küetzing; (*e*) *Navicula schroeteri* Meister; (*f*) *Navicula feuerborni* Hustedt; (*g*) *Navicula placenta* Ehrenberg var. *obtusa* Meister; (*h*) *Navicula glacialis* P. T. Cleve var. *septentrionalis* P. T. Cleve; (*i*) *Navicula platystoma* Ehrenberg; (*j*) *Anomoeoneis brachysira* (Brébisson) Grunow; (*k* & *l*) *forms of Navicula amphibola* P. T. Cleve; (*m*) *Navicula radiosa* Küetzing var. *minutissima* (Grunow) P. T. Cleve; (*n*) *Navicula lagerheimi* P. T. Cleve var. *intermedia* Hustedt; (*o*) *Navicula lyra* Ehrenberg var. *ehrenbergii* P. T. Cleve; (*p*) *Navicula crucifera* Grunow; (*r*) *Navicula cryptocephala* Küetzing var. *veneta* (Küetzing) Grunow; (*s*) *Navicula antiqua* A. Cleve; (*t*) *Navicula halophila* (Grunow) P. T. Cleve var. *subcapitata* Oestrup; (*u*) *Navicula anglica* Ralfs; (*v*) *Navicula gastrum* Ehrenberg; (*w*) *Navicula cancellata* Donkin var. *apiculata* Grunow; (*x*) *Navicula rotaeana* (Rabenhorst) Grunow; (*y*) *Navicula minuscula* Grunow; (*z*) *Navicula minima* Grunow; (a_1) *Navicula toornensis* P. T. Cleve; (b_1) *Navicula trituberculata* Prowse *sp. nov.;* (c_1) *Navicula hungarica* Grunow var. *lüneburgensis* Grunow; (d_1) *Navicula punctulata* W. Smith.

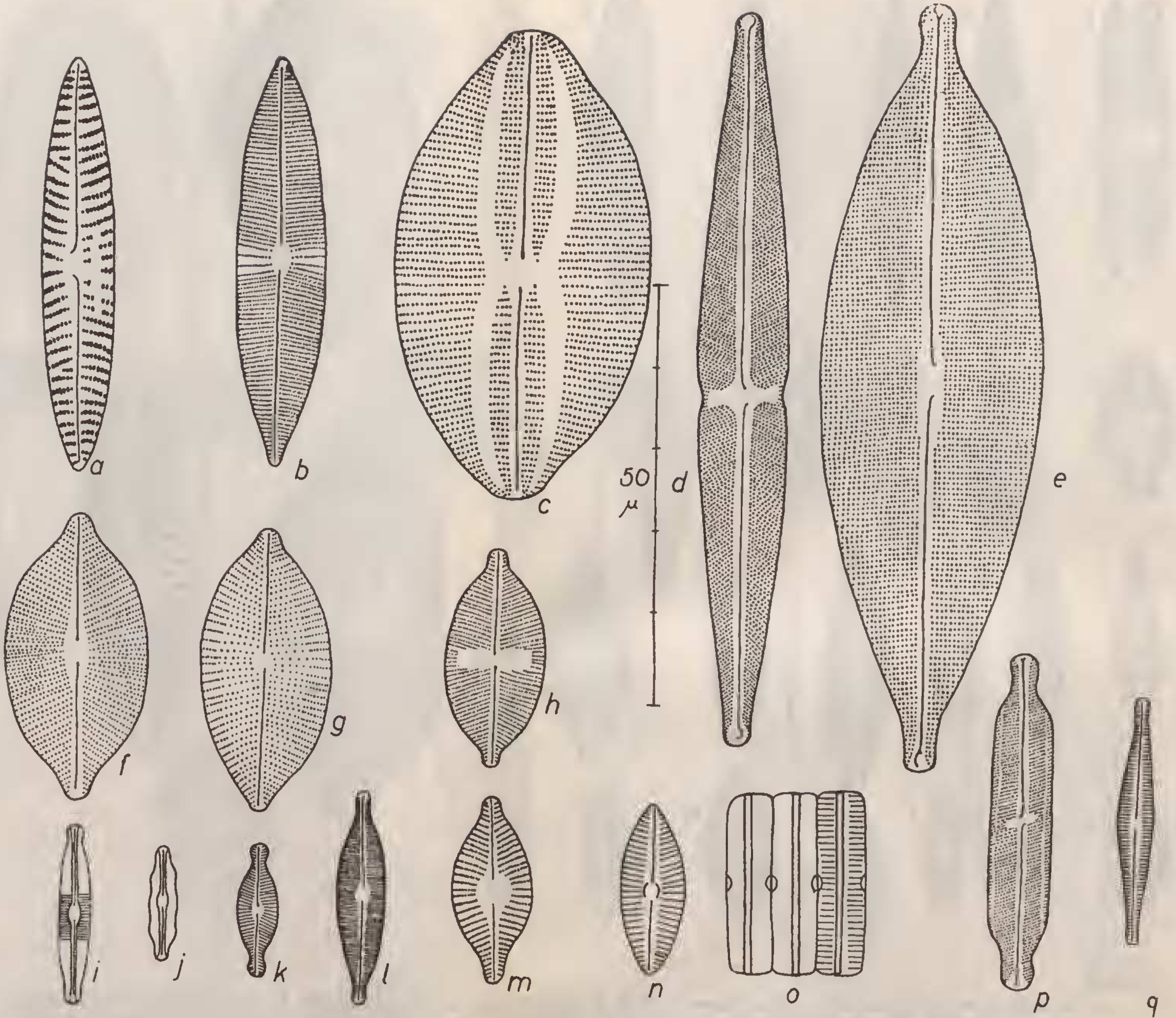

Plate XII.

(*a*) *Navicula arenaria* Donkin; (*b*) *Navicula grevillei* (C. A. Agardh) P. T. Cleve; (*c*) *Navicula lyra Ehrenberg* var. *dilatata* A. Schmidt; (*d*) *Stauroneis phoenicenteron* (Nitzsch) Ehrenberg var. *elegans* Prowse *var. now.;* (*e*) *Navicula cuspidata* Küetzing var. *ambigua* (Ehrenberg) P. T. Cleve; (*f*) *Navicula pusilla* W. Smith; (*g*) *Navicula brasiliensis* Grunow var. *minor* Prowse *var. nov.;* (*h*) *Navicula amphibola* P. T. Cleve; (*i*) *Navicula subtilissima* P. T. Cleve; (*j*) *Navicula tridentula* Krasske; (*k*) *Navicula hustedtii* Krasske; (*l*) *Navicula ostenfeldii* Öestrup; (*m*) *Navicula disparata* Hustedt; (*n & o*) *Navicula confervacea* Kuetzing; (*p*) *Neidium productum* (W. Smith) P. T. Cleve var. *minor* A. Cleve; (*q*) *Navicula microcephala* Grunow.

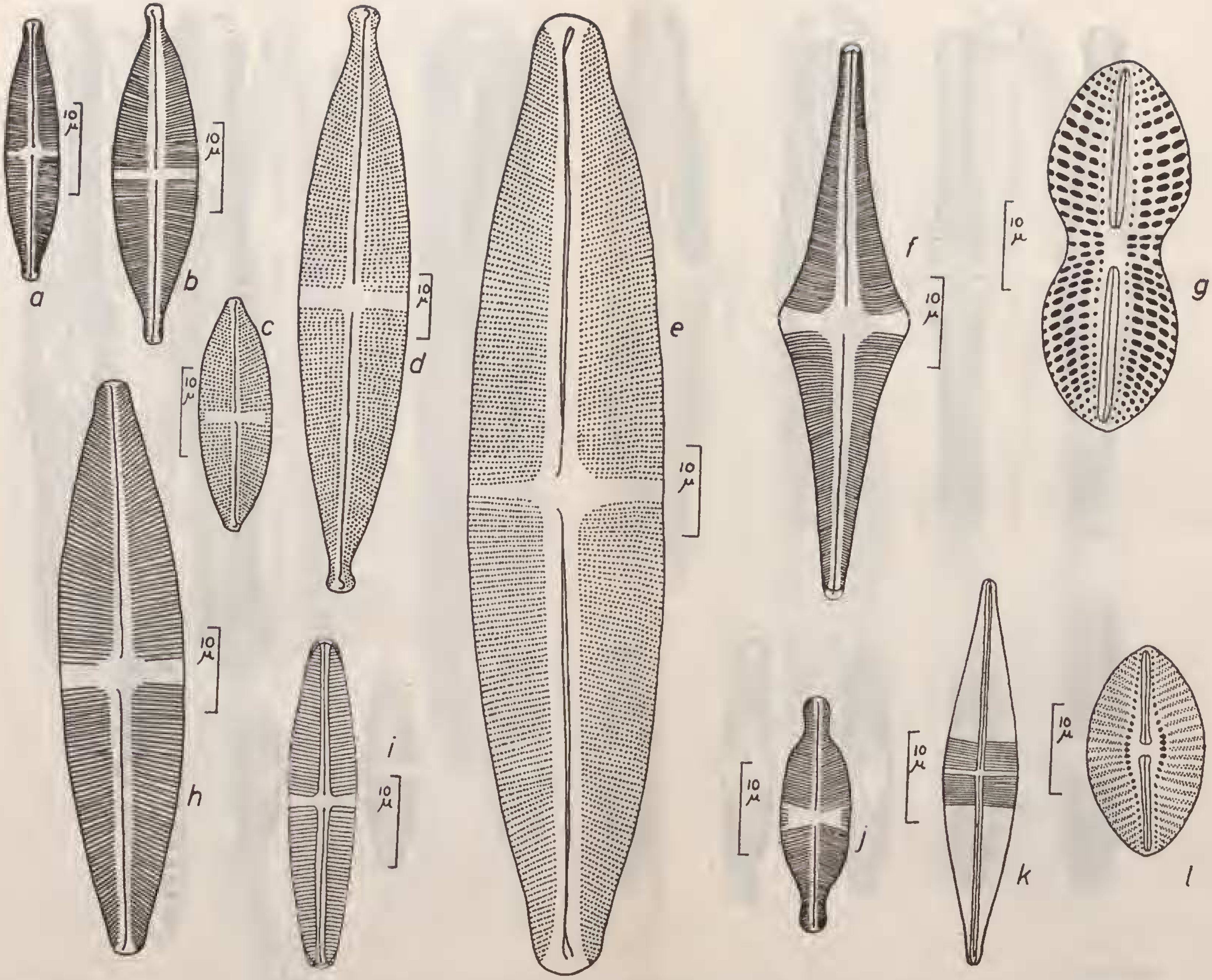

Plate XIII.

(*a* & *b*) *Stauroneis pusilla* A. Cleve var. *franconica* (May.) A. Cleve-Euler; (*c*) *Stauroneis phoenicenteron* (Nitzsch) Ehrenberg var. *halmei* Möelder f. *marginestriata* A. Cleve-Euler; (*d*) *Stauroneis anceps* Ehrenberg; (*e* & *h*) *Stauroneis phoenicenteron* (Nitzsch) Ehrenberg var. *intermedia* (Dipp.) A. Cleve-Euler; (*f*) *Stauroneis acuta* W. Smith; (*g*) *Diploneis bombus* Ehrenberg var. *minor* P. T. Cleve; (*i*) *Stauroneis obtusa* Lagerstedt; (*j*) *Stauroneis anceps* Ehrenberg var. *gothica* A. Cleve-Euler; (*k*) *Stauroneis anceps* var. *hyalina* Brun & Peragallo; (*l*) *Diploneis parma* P. T. Cleve.

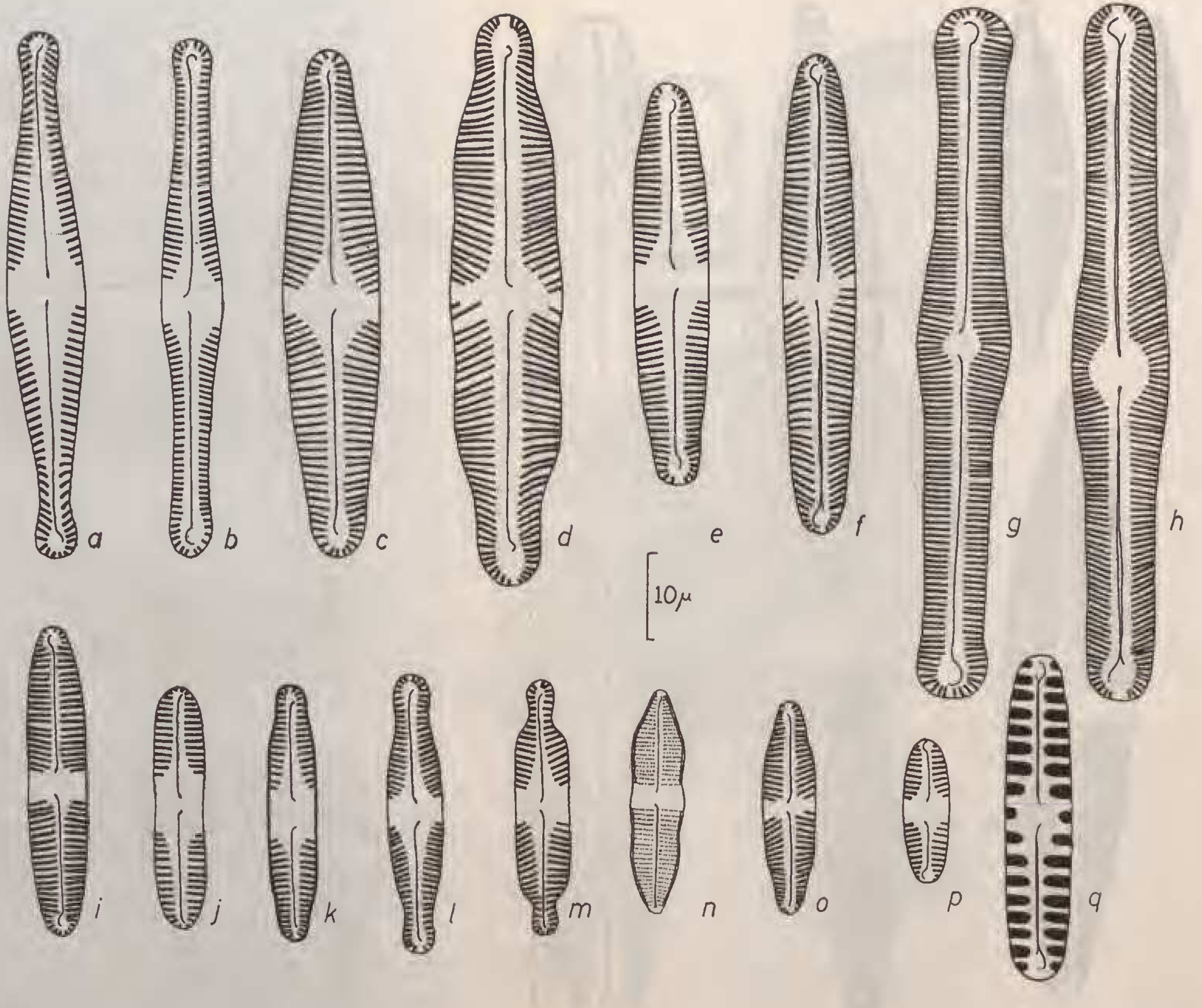

Plate XIV.

(*a*) *Pinnularia braunii* (Grunow) P. T. Cleve; (*b*) *Pinnularia gibba* W. Smith var. *interrupta* A. Cleve-Euler; (*c* & *e*) *Pinnularia microstauron* (Ehrenberg) P. T. Cleve; (*d*) *Pinnularia microstauron* var. *ambigua* Meister; (*f*) *Pinnularia microstauron* var. *brébissonii* (Kuetzing) Hustedt; (*g*) *Pinnularia tabellaria* Ehrenberg; (*h*) *Pinnularia bogotensis* (Grunow) P. T. Cleve var. *continua* A. Cleve; (*i, j* & *p*) *Pinnularia stricta* Hustedt; (*k*) *Pinnularia appendicula* (C. A. Agardh) P. T. Cleve var. *budensis* Grunow; (*l*) *Pinnularia braunii* (Grunow) P. T. Cleve. var. *amphicephala* (A. Mayer) Hustedt; (*m*) *Pinnularia biceps* Gregory var. *minor* (Boye Petersen) A. Cleve; (*n*) *Caloneis silicula* (Ehrenberg) P. T. Cleve var. *minuta* P. T. Cleve; (*o*) *Pinnularia brébissonii* (Küetzing) P. T. Cleve var. *hybrida* (Grunow) A. Cleve; (*q*) *Pinnularia borealis* Ehrenberg.

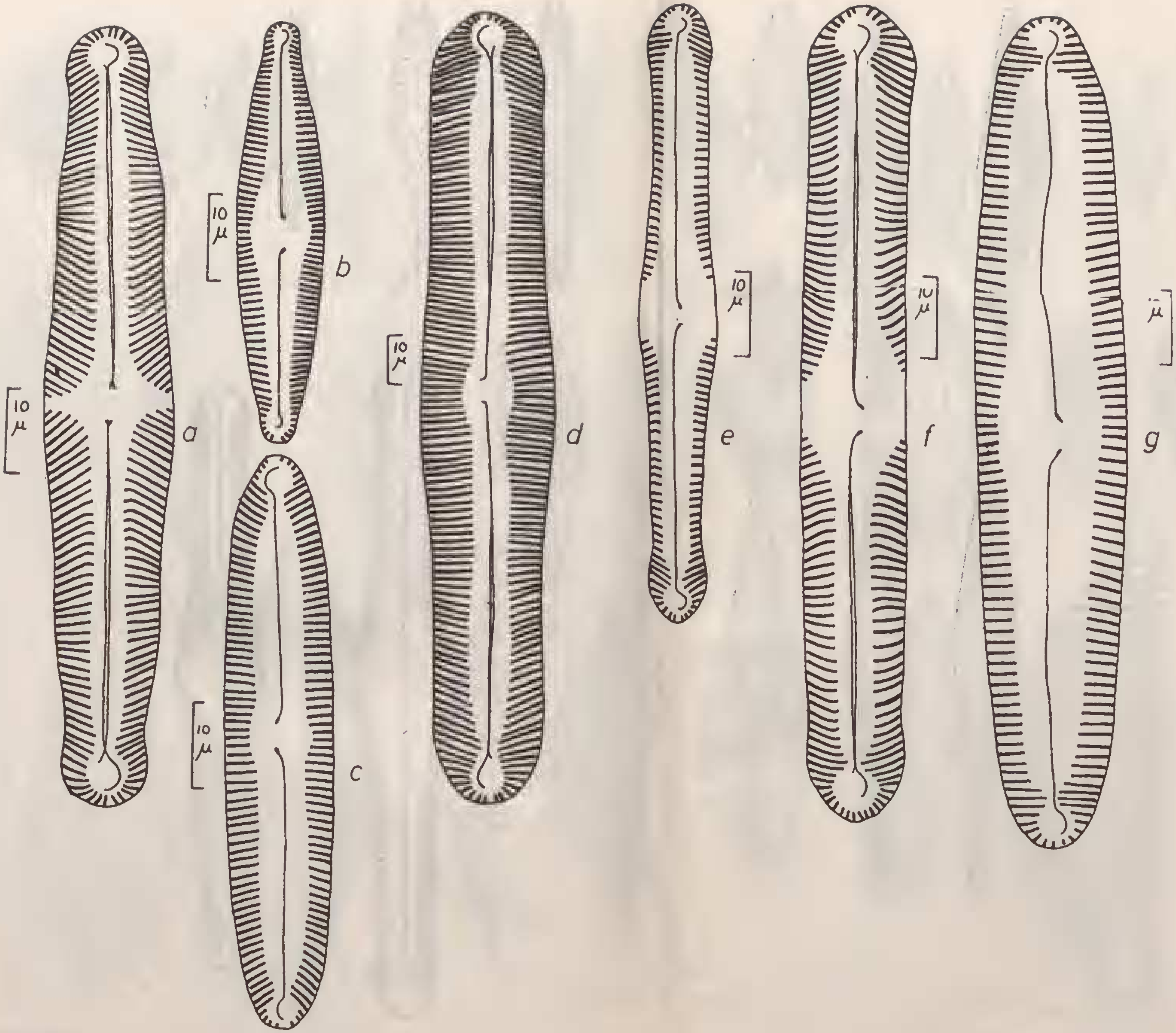

Plate XV.

(*a*) *Pinnularia stomatophoroides* Mayer var. *nuda* A. Cleve-Euler; (*b*) *Pinnularia parva* (Gregory) P. T. Cleve var. *parvula* (Ralfs.) A. Cleve-Euler; (*c*) *Pinnularia hemiptera* (Kuetzing) Rabenhorst; (*d*) *Pinnularia trigonocephala* P. T. Cleve; (*e*) *Pinnularia braunii* (Grunow) P. T. Cleve var. *amphicephala* (A. Mayer) Hustedt; (*f*) *Pinnularia stauroptera* (Grunow) P. T. Cleve var. *subparallela* Mayer; (*g*) *Pinnularia brevicostata* P. T. Cleve.

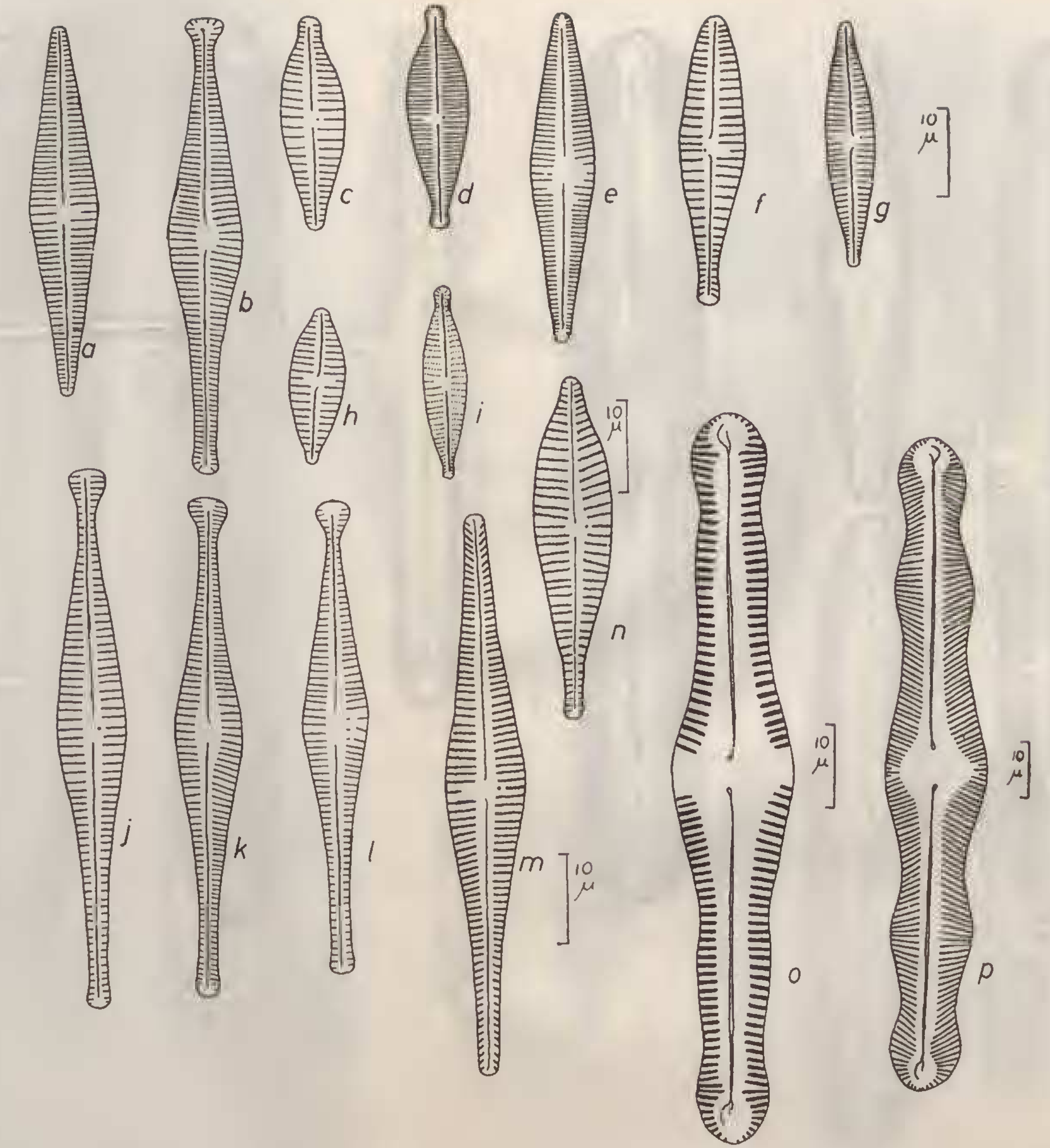

Plate XVI.

(*a* & *e*) *Gomphonema gracile* Ehrenberg; (*b*, *j*, *k* & *l*) *Gomphonema subtile* Ehrenberg; (*c*, *d*, *g*, *h*, & *i*) *Gomphonema parvulum* (Küetzing) van Heurck; (*f* & *n*) *Gomphonema subventricosum* Hustedt; (*m*) *Gomphonema longiceps* Ehrenberg var. *subclavata* Grunow f. *gracilis* Hustedt; (*o*) *Pinnularia polyonca* (Brebisson) P. T. Cleve; (*p*) *Pinnularia mesolepta* (Ehrenberg) W. Smith.

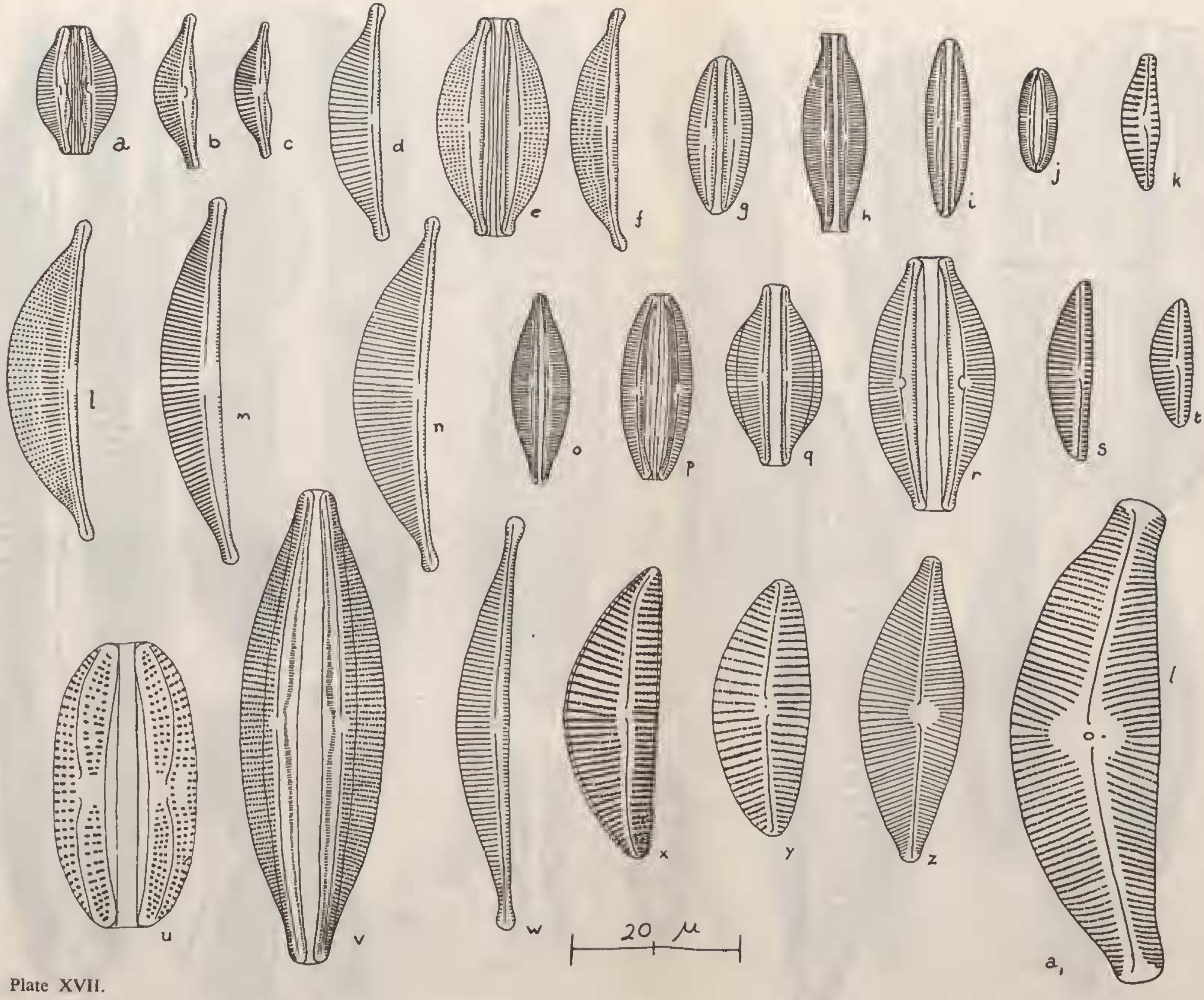

Plate XVII.

(*a, b & c*) *Amphora bitumida* Prowse *sp. nov.;* (*d*) *Amphora exigua* Gregory; (*e, f, n, q, v & w*) *Amphora acutiuscula* Kuetzing; (*g & i*) *Amphora angusta* (Gregory) P. T. Cleve; (*h & o*) *Amphora coffaeiformis* C. A. Agardh; (*j*) *Amphora perpusilla* Grunow; (*k*) *Cymbella javanica* Hustedt; (*l*) *Amphora holsatica* Hustedt var. *malayana* Prowse *var. nov.;* (*m*) *Amphora holsatica* Hustedt; (*p*) *Amphora libyca* Ehrenberg; (*r*) *Amphora normani* Rabenhorst; (*s & t*) *Cymbella ventricosa* Küetzing; (*u*) *Amphora proteus* Gregory; (*x*) *Cymbella turgida* Gregory; (*y*) *Cymbella kolbei* Hustedt; (*z*) *Cymbella cuspidata* Kuetzing; (*a1*) *Cymbella tumida* (Brébisson) van Heurck.

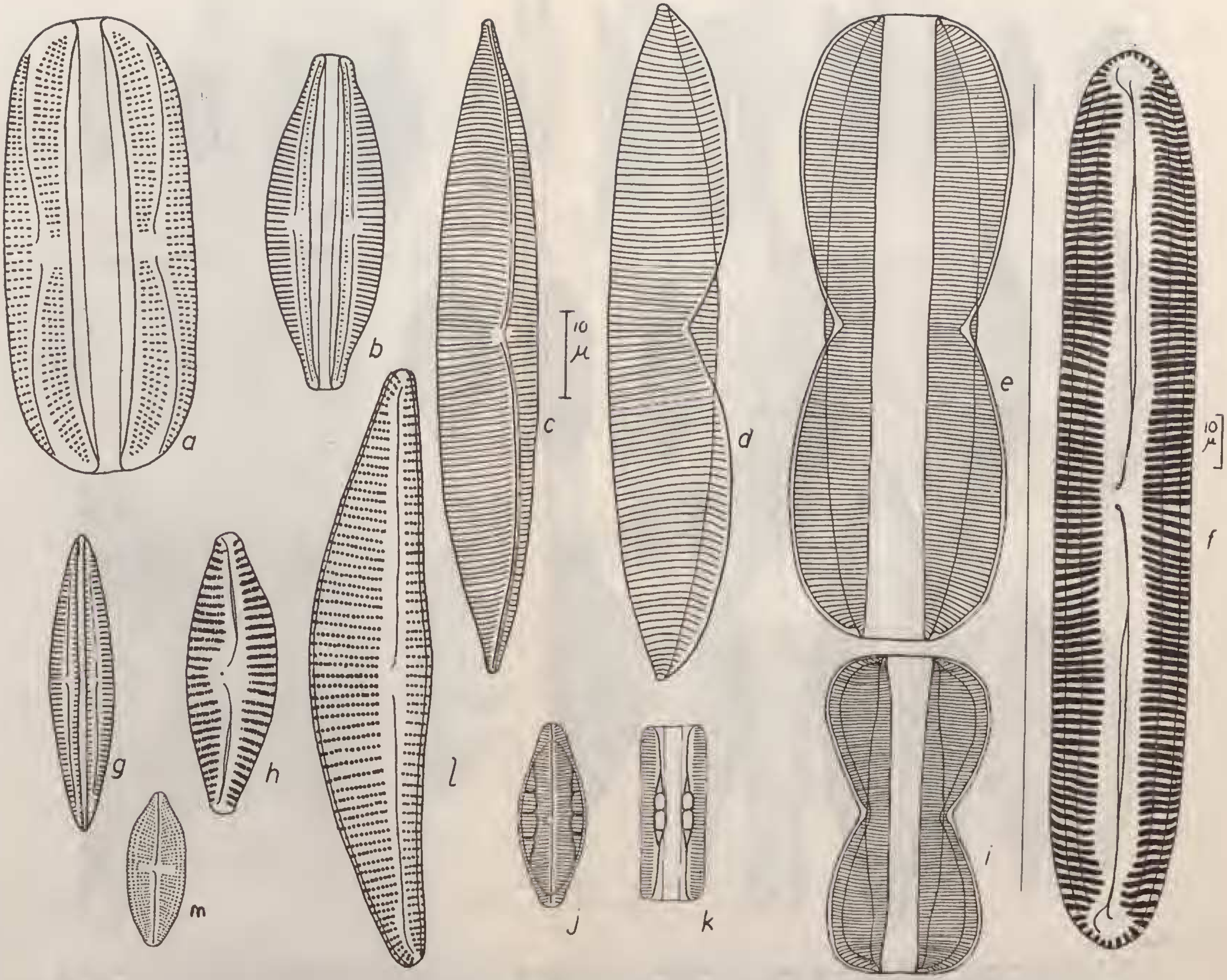

Plate XVIII.

(*a*) *Amphora proteus* Gregory; (*b*) *Amphora acutiuscula* Küetzing; (*c, d, e* & *i*) *Tropidoneis lepidoptera* (Gregory) P. T. Cleve; (*f*) *Pinnularia macilenta* (Ehrenberg) P. T. Cleve; (*g*) *Amphora angusta* (Gregory) P. T. Cleve; (*h*) *Cymbella sumatrensis* Hustedt; (*j* & *k*) *Mastogloia exigua* Lewis; (*l*) *Cymbella lanceolata* (Ehrenberg) van Heurck; (*m*) *Caloneis ladogensis* P. T. Cleve var. *cuneata* A. Cleve.

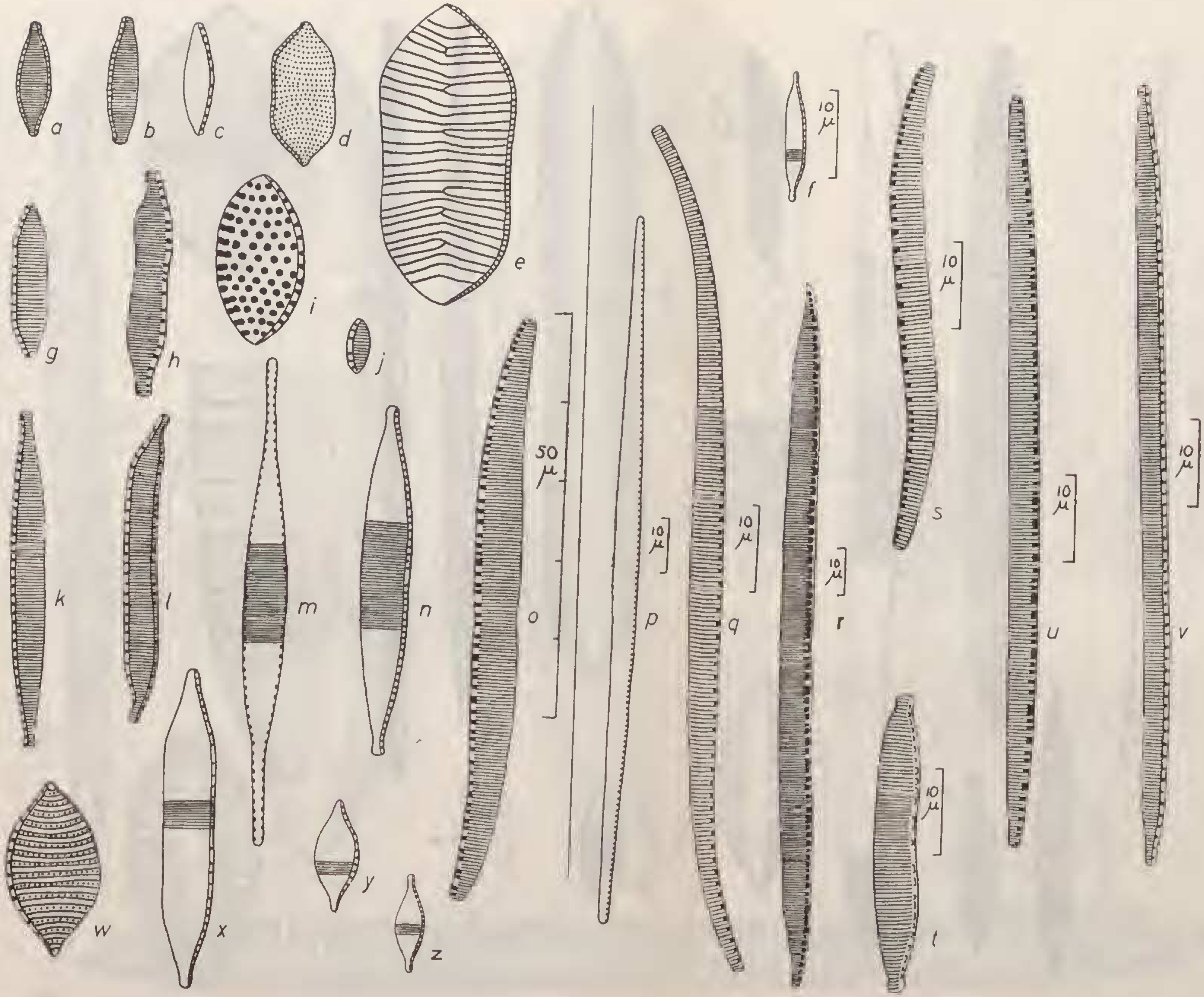

Plate XIX.

(*a, b & c*) *Nitzschia fonticola* Grunow; (*d*) *Nitzschia constricta* Gregory) Grunow; (*e*) *Nitzschia tryblionella* Hantzsch var. *victoriae* Grunow; (*f*) *Nitzschia microcephala* Grunow; (*g*) *Nitzschia amphibia* Grunow var. *acutiuscula* Grunow; (*h*) *Nitzschia parvula* Lewis; (*i*) *Nitzschia granulata* Grunow; (*j*) *Nitzschia communis* Rabenhorst var. *abbreviata* Grunow; (*k*) *Nitzschia palea* (Küetzing) W. Smith; (*l*) *Nitzschia sigma* (Küetzing) W. Smith var. *clausii* (Hantzsch) Grunow; (*m*) *Nitzschia acicularis* (Küetzing) W. Smith; (*n*) *Nitzschia stagnorum* Rabenhorst; (*o*) *Nitzschia obtusa* W. Smith var. *scalpelliformis* Grunow; (*p*) *Nitzschia subtilis* (Küetzing) Grunow; (*q*) *Nitzschia lorenziana* Grunow var. *subtilis* Grunow; (*r*) *Hantzschia amphioxys* (Ehrenberg Grunow var. *vivax* (Hantzsch) Grunow; (*s*) *Nitzschia ignorata* Krasske; (*t*) *Hantzschia amphioxys* (Ehrenberg) Grunow var. *capitata* O. Müeller; (*u*) *Nitzschia gandersheimiensis* Krasske; (*v*) *Nitzschia heufleuriana* Grunow; (*w*) *Nitzschia punctata* (W. Smith) Grunow var. *apiculata* A. Cleve-Euler; (*x*) *Nitzschia diducta* Hustedt; (*y & z*) *Nitzschia towutensis* Hustedt.

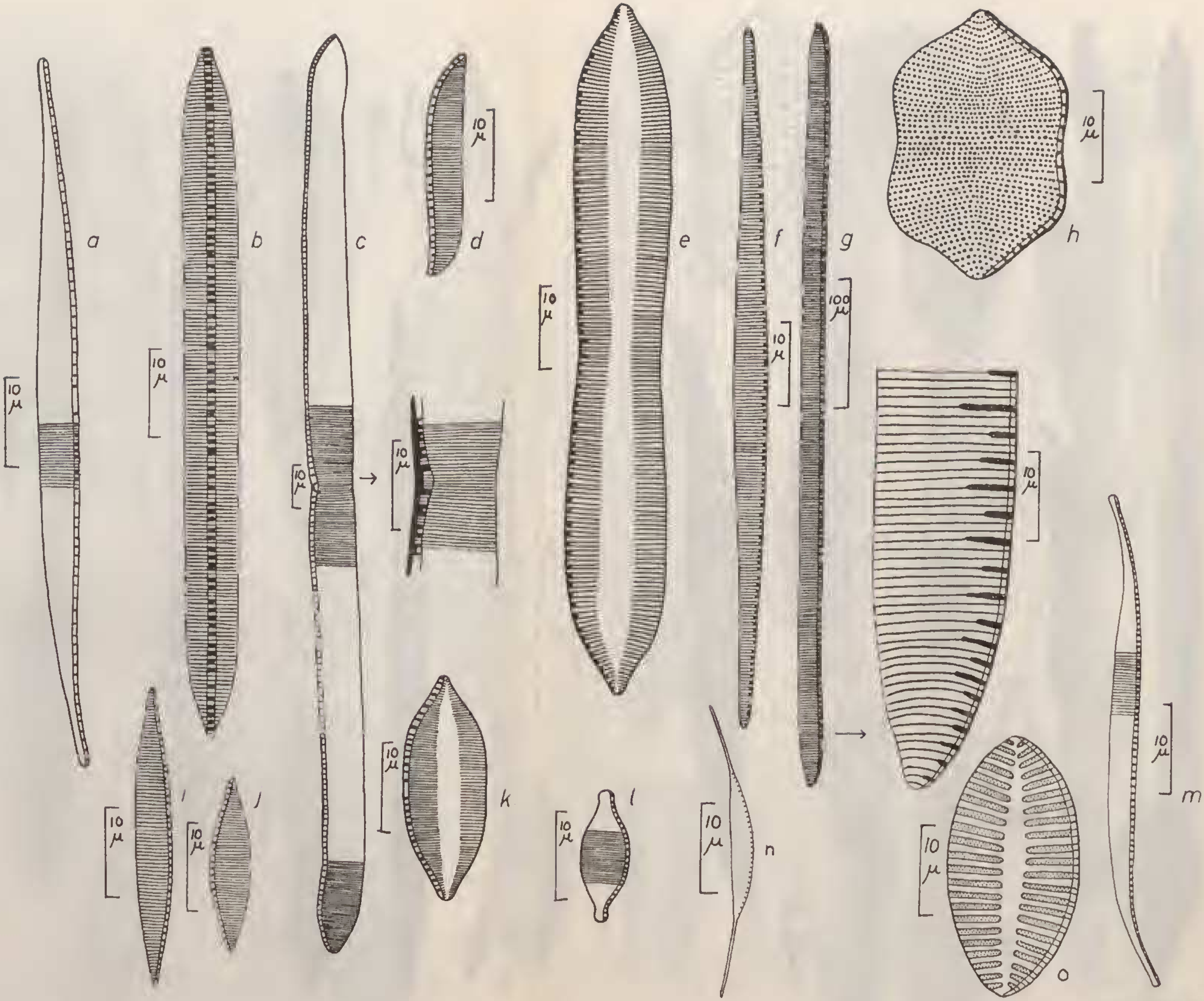

Plate XX.

(*a* & *m*) *Nitzschia sigma* (Küetzing) W. Smith; (*b*) *Nitzschia paradoxa* (Gmelin) Grunow; (*c*) *Nitzschia obtusa* W. Smith; (*d*) *Nitzschia obtusa* var. *scalpelliformis* Grunow; (*e*) *Nitzschia plana* W. Smith; (*f*) *Nitzschia subtilis* (Küetzing) Grunow; (*g*) *Nitzschia scalaris* (Ehrenberg) W. Smith; (*h*) *Nitzschia punctata* (W. Smith) Grunow var. *malayana* Prowse *var. nov.*; (*i* & *j*) *Nitzschia romana* Grunow; (*k*) *Nitzschia littoralis* Grunow var. *tergestina* Grunow; (*l*) *Nitzschia towutensis* Hustedt; (*n*) *Nitzschia closterium* (Ehrenberg) W. Smith; (*o*) *Nitzschia navicularis* (Brébisson) Grunow.

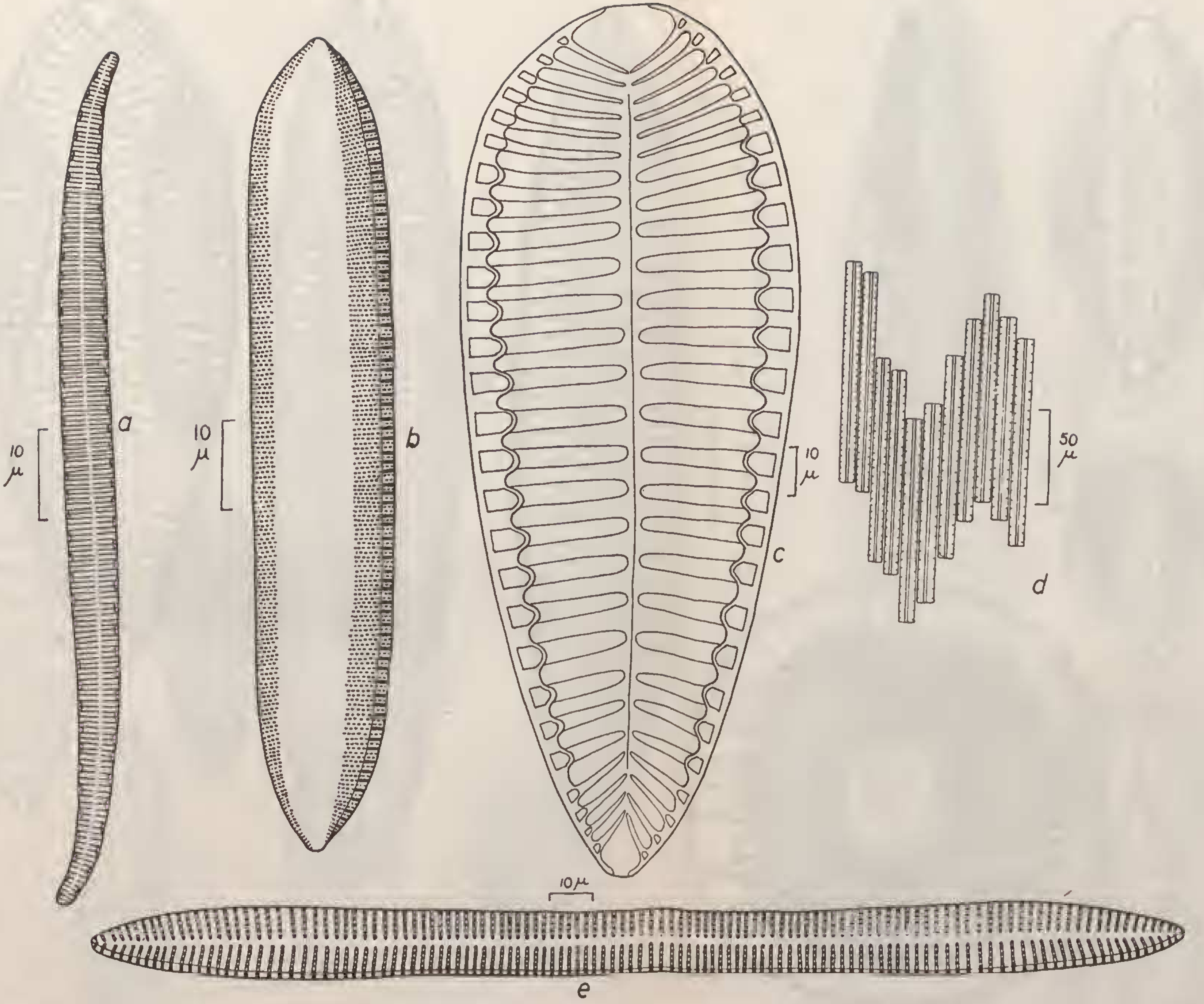

Plate XXI.

(*a*) *Stenopterobia intermedia* (Lewis) Fricke; (*b*) *Nitzschia marginulata* Grunow; (*c*) *Surirella robusta* Ehrenberg; (*d*) *Nitzschia paradoxa* (Gmelin) Grunow, habit of colony; (*e*) *Nitzschia surirelloidea* Prowse *sp. nov.*

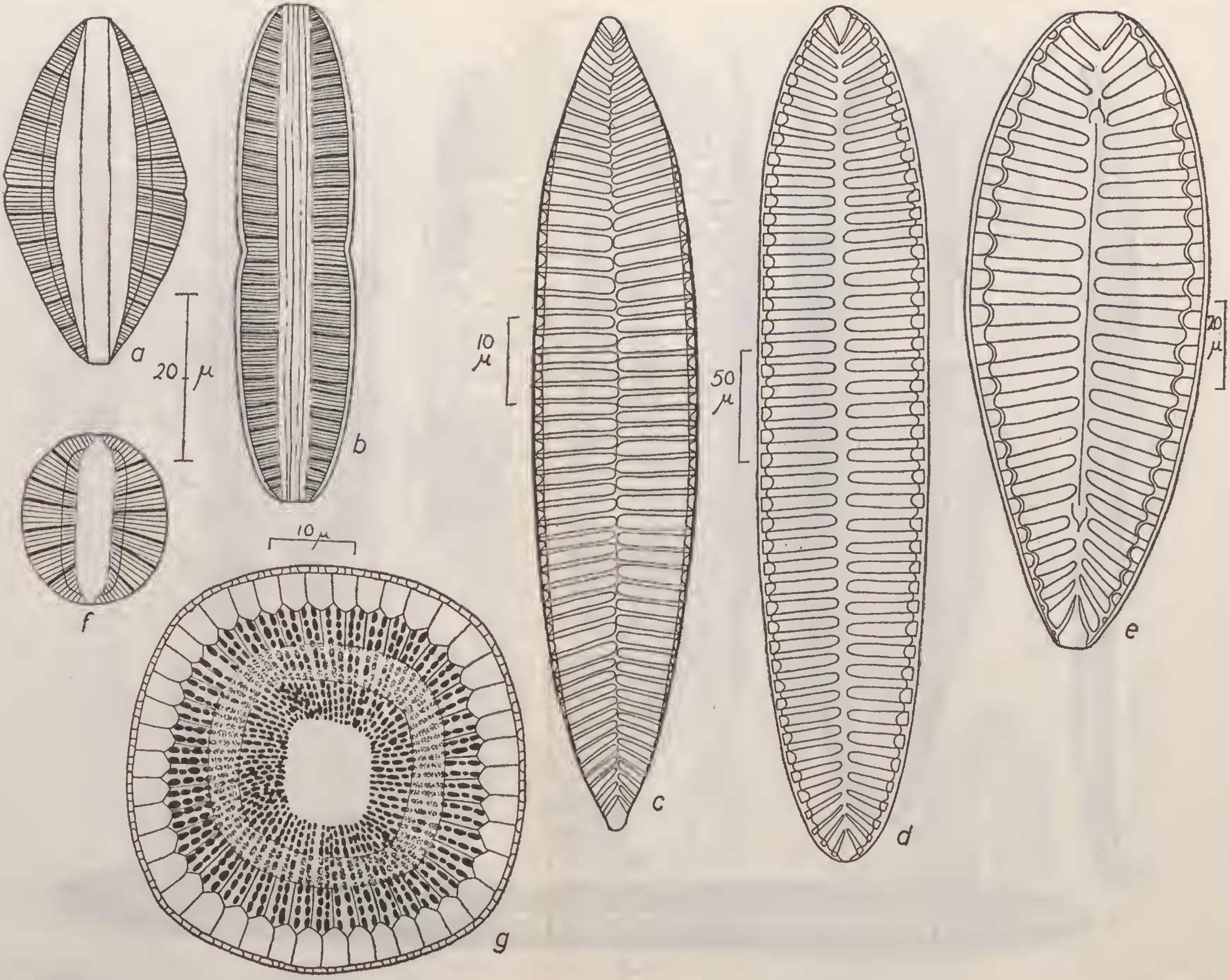

Plate XXII.

(*a*) *Rhopalodia gibberula* (Ehrenberg O. Müeller; (*b*) *Rhopalodia parallela* (Grunow) O. Müeller; (*c*) *Surirella lemmermanni* Hustedt; (*d*) *Surirella biseriata* Brébisson; (*e*) *Surirella capronii* Brébisson; (*f*) *Rhopalodia musculus* (Küetzing) O. Müeller; (*g*) *Campylodiscus clypeus* W. Smith.

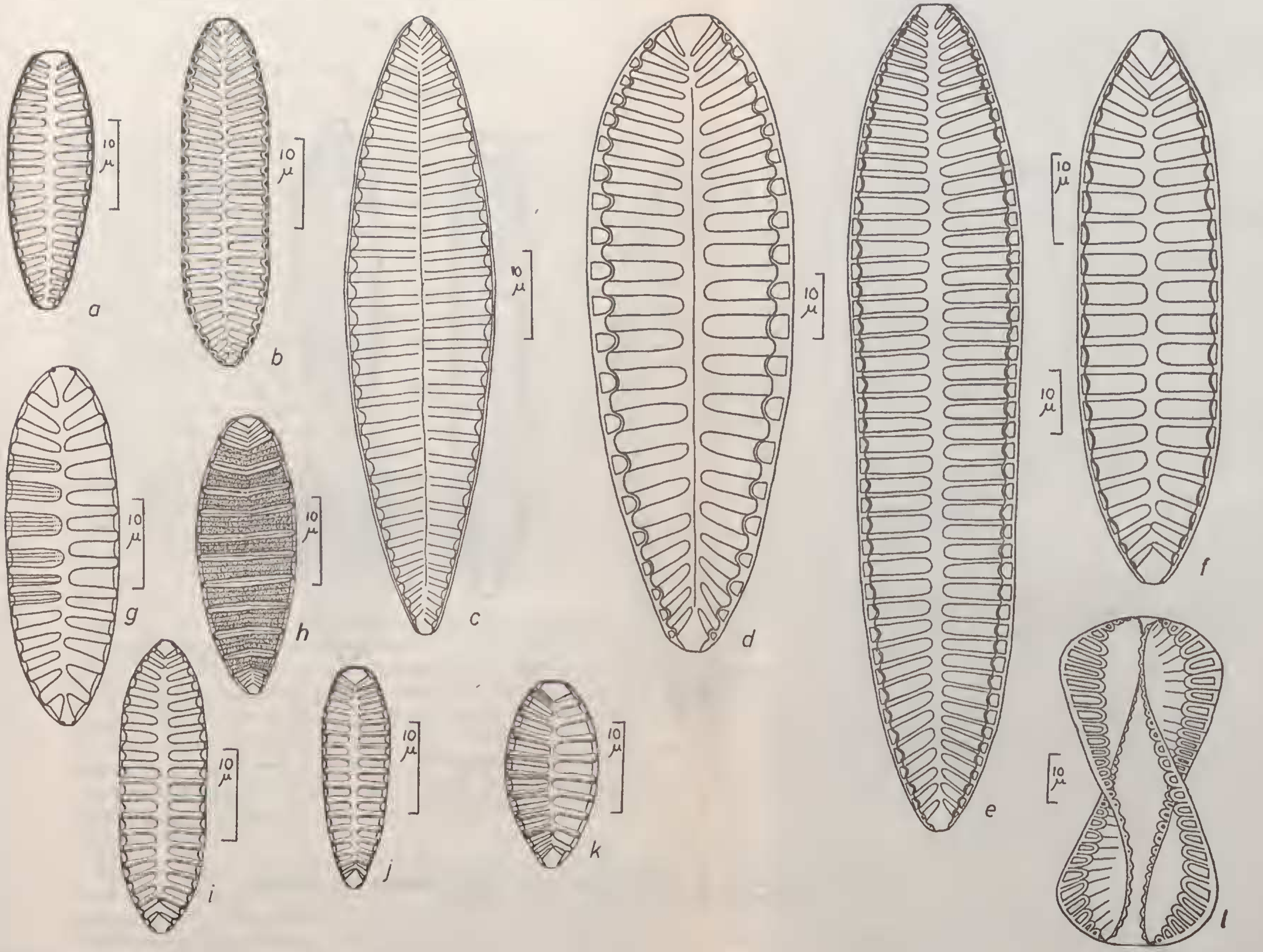

Plate XXIII.

(*a, h, j & k*) *Surirella tenuissima* Hustedt; (*b & i*) *Surirella angusta* Küetzing; (*c*) *Surirella angusticostata* Hustedt; (*d*) *Surirella robusta* Ehrenberg var. *splendida* (Ehrenberg) van Heurck; (*e*) *Surirella tenera* Gregory; (*f & g*) *Surirella linearis* W. Smith; (*l*) *Surirella spiralis* Küetzing.

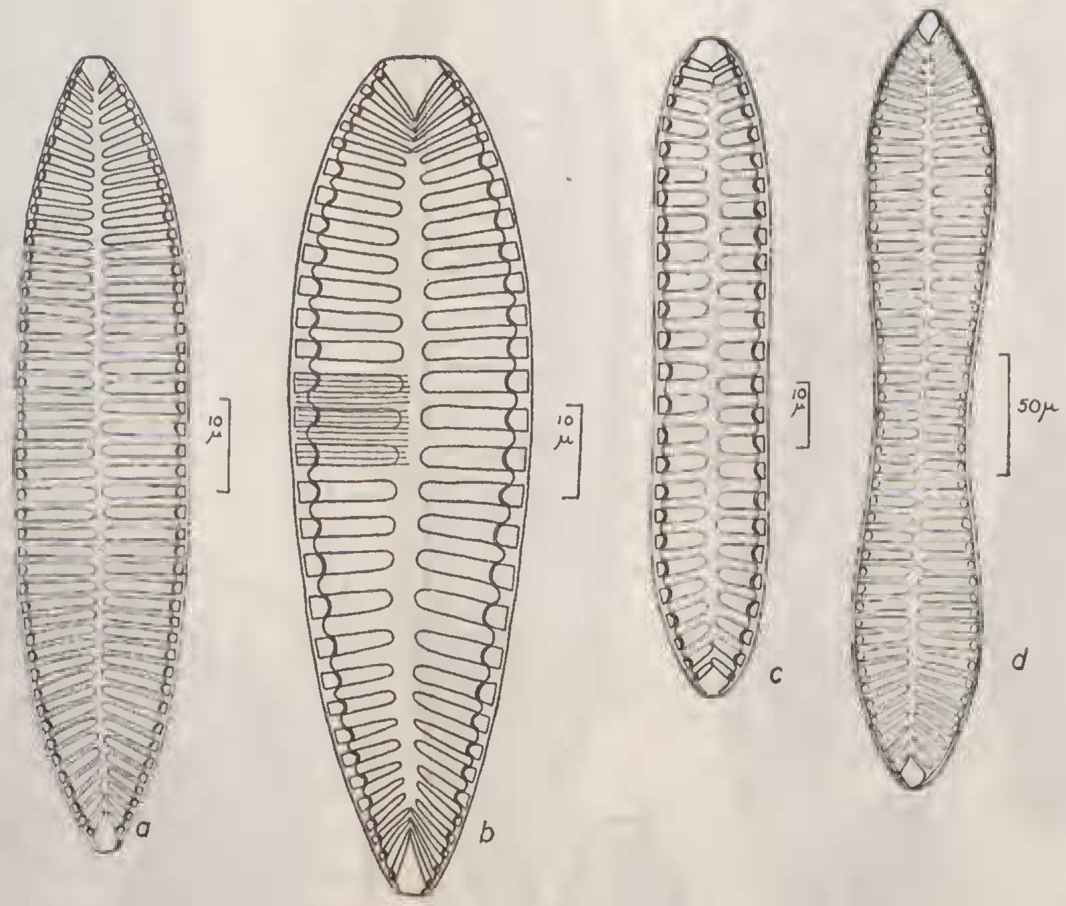

Plate XXIV.

(*a* & *c*) *Surirella linearis* W. Smith; (*b*) *Surirella robusta* Ehrenberg var. *splendida* (Ehrenberg) van Heurck; (*d*) *Surirella muelleri* Hustedt.